This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Library
of the
University of Wisconsin

Library
of the
University of Wisconsin

Some Facts

About

Treating Railroad Ties

Part III.

Essentials for Effective Work in Timber Treatment

By

W. F. GOLTRA

PRESIDENT, THE W. F. GOLTRA TIE COMPANY

CLEVELAND, OHIO

1913

178482
OCT 23 1913
SSHH
.G58
3-6

641 5570

CONTENTS.

Part III.

Page

Preface 3

Editorial, Railway & Engineering Review on Shell Game in Timber Treatment 4

Letter to Editor of Railway & Engineering Review, concerning Depth of Penetration in Timber Treatment, from Mr. J. A. Lounsbury 5

Editorial, Railway & Engineering Review on Decay and Mechanical Wear 6-8

Letter to Editor Railway & Engineering Review on Life of Treated Piling in Louisiana, from an Engineer..... 9

Editorial, Railway & Engineering Review, Pertaining to Some Questions in Tie Treating Economies 10-11

Letter and Editorial Note on The Shell Game in Timber Treatment. 12

Letter on same subject from an Engineer 13

Letter to Editor Railway & Engineering Review, On Essentials for Effective Work in Timber Treatment, from W. F. Goltra....14-15-16

PREFACE TO PART III.

The booklet entitled, "Some Facts About Treating Railroad Cross Ties," published two months ago, has met with such favor and demand that the Author concluded to collect in a convenient form some editorials and correspondence which appeared in the Railway and Engineering Review, in the months of November and December, 1912, and make it Part III of his treatise on treating railroad ties. The questions of "Mechanical Life of Ties" and "Essentials for Effective Work in Timber Treating" are discussed and it is hoped the information contained in this pamphlet may be found interesting as well as instructive to the reader.

THE AUTHOR.

Cleveland, Ohio, January 10th, 1913.

(EDITORIAL FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 2, 1912.)

THE SHELL GAME IN TIMBER TREATMENT.

Evidence of malpractice in timber treatment continues to appear. An engineer writes us that he was "just in from a three weeks' bridge inspection trip, and some of the developments of treated timber have been eye openers" to him. He then goes on to tell about shallow penetration of the preservative in bridge timber that came under his observation, decay having well progressed in some of the creosoted piles after a service as short as only four years.

It is regretful that, considering past experience in this country, such reports of creosoting work should be possible. It is not so long ago, when timber was cheaper, that creosoting of railroad ties and other timbers was but little practiced in this country, being put out of consideration because of the cost, and for that reason only. Because of the predicted increase in price of timber, however, engineers looked forward to the time when creosoting, which was much more expensive than other forms of timber treatment then in vogue, would become an economical practice. Judging from the long use of creosoting in Europe it was generally understood to be the best known method of treating timber for protection against decay. This view was so generally accepted that no question was raised as to the superiority of creosote for an antiseptic in timber treatment.

Eventually more extensive use of creosoting came about, and rather sooner than had been expected, but the application was not in all cases in accordance with what had hitherto been considered standard practice, various schemes for saving medicine being proposed as substitutes for full treatment of creosote. Doubt was entertained as to whether any of these partial-dose methods would result satisfactorily. In fact one of the best authorities, if not the best acknowledged authority, on timber treating in this country, some eight or ten years ago, observing the tendency to adopt experimental methods which were being exploited under the name of "creosoting," in lieu of what was known to be good practice, predicted that disappointing results were bound to follow, and we are inclined to believe that his prophecies are coming true.

It was remarkable that many railway managements who were taking up timber treatment for the first time seemed to be under the impression that all timber-treating methods, so far as this country was concerned, were experimental, when, really, long-time records were available that would have shown the real worth of either the creosoting or zinc chloride methods had these records been sought and consulted. Undoubtedly some were misled by claims quite widely circulated at the time, to the effect that the records of any processes of treatment which had been practiced in this country by the railroads were too meager to prove anything as to the merits of the kinds of treatment that had been

used. Hence it was supposed or, at any rate claimed, on the part of some, that timber treatment work in this country was something entirely new and essentially experimental, so that the logical thing to do was to try everything that was offered. At any rate much creosoting of the shell-deep, tar-mixed or other spurious kind has been carried on, and hardly any better results could be expected than is reported by the correspondent above quoted.

In France, where the creosoting of railroad ties is an old industry, heavy treatment has been the rule, forcing into the timber all of the creosote that it would take. In England, also, the creosoting of railroad ties is an old industry but, on the average, a somewhat smaller quantity of creosote per unit volume of timber has been used than was common practice in France. In comparisons of the practical results obtained in the two countries it has always been reported that the life obtained from creosoted ties in France was longer than in England, purely and simply because of the larger amount of material used per unit of the treated timber. If the long-standing results of experience in these countries have been correctly represented, and if any significance attaches to them, we fail to see the logic in much of the supposedly experimental work that has been done in this country. If the life of the timber depends upon the amount of preservative injected, as long-time experience seems to teach, then scrimping the material might be expected to result as scrimping usually does in other engineering work, no matter under what name or disguise the art is practiced.

(FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 9, 1912.)

DEPTH OF PENETRATION IN TIMBER TREATMENT.

Chicago, Nov. 5, 1912.

Editor Railway and Engineering Review:

The editorial on "The Shell Game in Timber Treatment," appearing in your issue of November 2, is a rather severe shot at some one, and causes the reader to wonder against whom it is aimed, the independent treating companies, the promoters of patented treating processes, or the railroads themselves.

Is it not a fact that the independent companies, doing contract work, are willing to inject into the timber all the antiseptic material that the railroads are willing to pay for? Is it not true that the patented processes are designed to give a fairly good degree of immunity at a low cost, and that the railroad companies are the beneficiaries of the reduction in price? Also is it not true that the principal reason for inadequate treatment is that the railroads will not stand for the expense of a thorough treatment?

Of course, if the treating companies do not furnish the quality or quantity of treatment called for in their contracts, or if they, or the

promoters of the patented processes misrepresent the benefits to be derived from partial treatment, they are blamable and should be denounced, but if they make their representations in good faith and do their work honestly, the responsibility rests with the purchaser. If he expects something for nothing, or if he is willing to take a chance on the economy of a light treatment, knowing that he usually gets no more than he is willing to pay for, then the responsibility of success or failure is upon him.

Nor should the railroads be blamed thoughtlessly for their attitude. The conservation of tie life includes more factors than that of decay resistance alone. Ties depreciate from wear as well as decay, and while wear and decay are influenced one by the other, and the effects can not in practice be entirely differentiated, it is true that the highest economy can be realized only by an intelligent balancing of the means of guarding against these two destructive agencies.

While ties, treated to refusal, may be given a life of upwards of twenty years, measured in terms of decay only, there can certainly be no economy in expending the amount of money necessary to obtain such treatment if the mechanical life is limited to a much shorter period. This seems to be the condition which has prevailed in the past. The greatest economy is therefore secured by providing the best mechanical protection possible, and spending the smallest amount for treatment which will give a decay immunity equal to the mechanical life. We have thus three factors in the problem: the cost of mechanical protection, the cost of treatment and the cost of new ties.

If the average cost, in the track, of soft wood ties, untreated, is 60 cents, and the average life, untreated, is six years, it is obvious that no road would be warranted in spending more than 60 cents for mechanical protection and treatment to secure double the life. Otherwise it would be cheaper to buy a new tie.

The treatment to refusal of soft ties would give an average injection of not far from 16 pounds of oil per cubic foot, and the cost of this treatment would be not less than forty-five cents per tie. The best mechanical protection possible with present day devices (which will not give a life equal to the decay resistance obtained by this treatment) would cost at least 35 cents, a total of 80 cents per tie. It is, therefore, apparent that too much would be spent for treatment because the treatment and mechanical protection are not properly balanced, and because a new tie could be bought and put in the track for 60 cents. If a service of more than 16 years could be obtained by means of the above treatment and protection, then it would begin to show some economy. It is in the mechanical protection, however, that the limit is soonest reached.

With the quality of roadbed, and the wheel loads prevailing in this country no comparison as to tie life can justly be drawn between the United States and France. Over there they do not wear their ties out. We do, and therefore, before it is economically possible for us to give ties the maximum treatment, it will be necessary to provide against their mechanical destruction for a period equal to the decay immunity secured

by such treatment. Mechanical protection should be the first to receive consideration, because upon it depends, to a great extent, the value of the chemical treatment. The important thing to be kept in mind is that only by increasing the mechanical life in a corresponding degree, can the chemical treatment be much increased with economy.

J. A. LOUNSBURY.

(EDITORIAL FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 9, 1912.)

DECAY AND MECHANICAL WEAR OF TIES.

A correspondent refers to our editorial of last week, in which we commented upon inefficient work in timber treatment, and he would like to know against whom these remarks were aimed—"the independent treating companies, the promoters of patent treating processes or the railroads themselves." Answering him in direct manner we may say that we have known all three of these interested parties to be accused of responsibility for scrimping the material in timber treating work. As to this it remains only to be said that if the poor work is chargeable to the wood preserving contractors or to the promoters of patented processes or patented solutions, the remedy is obvious; but if it is chargeable to the railroads themselves, as we believe it is in some instances that have been brought to our notice, then, very clearly, no one else is to blame, as our correspondent very truly observes. Thus far, there is really nothing to argue about, granting that the responsibility for the poor work can be definitely located.

A thing in our correspondent's letter that is of real interest to discuss is the point which he raises in reference to economy in the partial-dose method of treating railroad ties. He seems to uphold such practice, taking the ground that to inject into the timber all of the creosote that it will receive might preserve it so well against decay that it would outlive its usefulness! According to this view thoroughly treated ties will resist decay for a period longer than the "mechanical life" that is possible, the tie actually failing from wear before it has become decayed. His proposition is broadly enough stated, for he takes into account that wear and decay are to some extent interdependent, which view is correct, the wear of timber being accelerated as decay sets in, while the wearing of ties, as by rail cutting, undoubtedly promotes decay by making ready access for water to the interior fibers of the wood.

We are pleased that Mr. Lounsbury has brought up this question, for we think it a timely one. The idea is, indeed, to some extent current that it would not pay to practice full creosote treatment of railroad ties in this country, for not a few seem to think that the life of ties treated by the best and most thorough processes would depend

more upon mechanical wear than upon decay of the timber. A railway official not long since told the writer that his company was treating its ties with a limited amount of creosote, the aim being to preserve the timber only as long as the tie could resist mechanical wear.

So much has been said about this matter of "mechanical wear" that we think it might be well to get a correct understanding as to just what the term is meant to convey. Does it mean rail cutting? or spike killing? or both of these and something more? In his reference to the subject our corresepondent confines his remarks to soft wood ties. Now, as to this kind of timber, it must be conceded that under heavy traffic mechanical protection is necessary whether the ties are treated or not. It is no uncommon thing to find untreated pine ties or ties of other soft woods ruined by rail cutting before the wood has decayed. Applying, then, to such ties the principle of gaging the thoroughness of the treatment to suit the prospective durability of the ties under mechanical wear, very clearly there should be no treatment at all. Now, of course, rail cutting occurs at varying rates, according to the density of the traffic, magnitude of axle loads, excellence of rail surface, and perhaps other factors; and in some instances it might be so slow that unprotected ties will fail from decay sooner than from rail cutting. In such cases the question of preservative treatment is clearly worth considering; but, let us ask, who would think of putting a treated tie into the track where the conditions are such that rail cutting is bound to occur, without protecting it with tie plates? In fact, it is only a matter of common knowledge that, so far as soft wood ties are concerned, tie plates are required whether the ties are treated or not, and they have long been, and are still being, used by the million on untreated ties. Tie plates were a standard track device all over the country years before tie treatment was practiced to any considerable extent east of the Mississippi river. It is, therefore, foxy argument to combine cost of mechanical protection with cost of treatment, in arriving at the cost of treated ties in the track, and not to consider it at all, as does our correspondent, in stating the cost of untreated ties. He assumes the cost of untreated ties in the track at 60 cents; the cost of mechanical protection at 35 cents, and the cost of treatment, to refusal, at 45 cents. He then would have us believe that the cost of treated ties compares with the cost of untreated as 140 cents to 60 cents; when really, following the common practice of our railroads, the cost of mechanical protection should be included in both cases; and we then have the cost of the treated tie, mechanically protected, comparing with the cost of the untreated tie, also mechanically protected, as 140 cents to 95 cents. This is how the arithmetic of this question looks to the writer.

Again, if the rail cutting action is severe enough to affect the life of oak or other hard wood ties, independently of failure by decay, we take it that no competent engineer would hesitate to apply tie plates to such timber. In the case of treated oak, tie plates should certainly be used if there is liability of failure from rail cutting sooner than by decay; and, with such mechanical protection, whether the tie be soft wood or

hard wood, we should think it would be the part of wisdom to treat the tie as thoroughly as possible, granting that tie plates can effectively protect it from rail cutting, and as to this we think there is hardly any question. Is it not true that in most cases where ties have failed from wear there has not been adequate protection against rail cutting, or that tie plates were not applied until after rail cutting had begun?

As to failure by spike killing, it is true that the life of ties, both treated and untreated, may be shortened by injudicious changing of the position of spikes when relaying rails, or in regaging, or in shimming, or perhaps some other kinds of track work where respiking is done; but such practice is independent of any question of tie treatment. We have many times called attention to this thing, and it does not necessarily follow that spike killing of ties is bound to result in the course of a more or less definite term of years, although it does occur from improper methods of work. It is bad practice when relaying rails to change the position of each spike to the opposite side of the tie face. The driving of a spike of any kind, or in any manner, into a tie, necessarily severs the fibers in a goodly portion of the width of the tie, and as often as this operation is repeated, in a direct line across the tie, by so much nearer is the tie at that point cut in twain. When relaying rails each spike, if practicable, should be redriven in the same hole or the same hole plugged, and where proper practice is observed in redriving spikes the destruction of the tie from this cause need not result. Neither is it to be overlooked that if ties were bored for the spikes, instead of driving the spikes into the solid timber, thereby crushing and displacing the fibers, the integrity of the timber in contact with the spikes could be longer maintained. In all treated ties boring for the spikes should certainly be practiced, the boring being done preferably before treatment, and, at all events, preservative material should be poured into the holes before the spikes are driven. So much for the mechanical wear of the ties from the spikes.

As to the question of the decay of the wood fiber surrounding the spikes before such occurs in the body of the tie, the conditions are all the worse the shallower the penetration of the treating solution. The spike must necessarily penetrate the interior of the tie, and if there be no preservative there, what is to prevent decay, especially where spikes have been pulled and the holes not carefully plugged?

In what other ways can ties fail through mechanical wear than in those stated? We have, to be sure, seen ties reduced in size to that of a fence post, nothing remaining but the heart of the timber, the tie having seemingly been pounded to pieces against the corners of particles of stone ballast, but in such cases careful investigation would show that the sap or exterior parts of the tie had softened from decay before such erosive action from the ballast had occurred. But, laying all the foregoing questions aside, who can state anything definte as to the "mechanical life" of ties, under such traffic conditions as exist in this country? We will grant, of course, as our correspondent points out, that ties in this country undergo greater pressures from train movements than is the case in France; but need there really be such a thing as destruction of ties from

mechanical wear alone if proper attention be given to protection by tie plates and reasonable practice be followed in respect to the driving and redriving of the spikes? He concedes immunity from decay for upwards of twenty years for ties "treated to refusal." Is it impossible, by ordinary means, to realize in practical life of the tie this increased longevity of the wood itself?

Another thing to consider in this connection is the extreme variability in the penetration of the preservative where the ties are not treated "to refusal." If one thing is known better than some others in the timber treating business it is that segregation of pieces that are difficult of penetration, from those that take the treatment readily or at normal pressures, is impracticable; and this is true among timbers of the same species and having the same physical appearance. For this reason grouping of timber for treatment by sorting over sticks of the same species is rarely if ever attempted, and nothing can be accomplished if it were done. In practical work the refractory pieces get nothing more than a superficial staining from the preservative until after the easily penetrable timbers in the same cylinder are filled to the core. If then, the process is stopped at a limited absorption per unit volume of timber, or at what is known as "light treatment," a portion of the sticks or ties will have absorbed the bulk of the preservative and the refractory pieces will be penetrated but skin deep. There is only one safe method to pursue, and that is to work the pumps on the cylinders to the point of downright refusal of the timber to take in more of the solution, and even then some of the pieces will not be treated clear through.

In view of this fact, and if our correspondent's quotation of 45 cents (or thereabouts) for creosote treatment to refusal is correct, where is the logic in backing down at that figure when 34 or 35 cents per tie is a price commonly paid by our railroads for partial-dose treatment? Applying the two methods to a tie costing 60 cents in the track, the comparison is as $1.05 to 95 cents; and why take chances on such a vast difference in practical results as is possible, for such a small relative difference in cost?

After all that has been said let us inquire whether anyone in this country has tried creosoting of railroad ties to refusal; what kind of timber was treated? what does it cost? have the ties been properly protected from mechanical wear? how long will they last? and has it been demonstrated or can it be foreseen that such thorough treatment will not pay? If it will not pay, may not the zinc chloride treatment, which has been well tried out, yield results that are equal to those of creosoting half way done at double the cost of applying zinc chloride? Unless one has some such information and experience for guidance what is the use in trying to discourage trial of methods that are known to be in line with the best results possible?

Once upon a time a delegation visited a tribe of Indians, with the object of working some kind of a steal (no reflection upon the motives of our correspondent is here intended). After the Indians had given due consideration to the proposition, to see what might be in it for them, the chief of the tribe said to the spokesman of the delegation: "You are

like unto a man standing on a bald butte, where there is no grass, talking to the wind.'' If there is nothing to offer against full-dose creosoting but bare assumptions, by all means let it be tried, to see what will come of it. If there is definite knowledge of results in the mechanical wear of ties that are afforded reasonable means of protection, it will be like grass under foot if persons who have such information will come out with it. We feel certain that a great deal of education along these lines is possible, and we invite readers to use these columns for such discussion of the matter as may be prompted from experience and observation.

(FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 16, 1912.)

LIFE OF TREATED PILING IN LOUISIANA.

November 12, 1912.

Editor Railway and Engineering Review:

Referring to the editorial entitled ''The Shell Game in Timber Treatment,'' published in your issue of November 2, and the letter of Mr. Lounsbury and editorial comment in the issue of November 9: The writer has had recent experience with treated piling in Louisiana, and he contributes the results of his observations with the hope that it may shed some light on the question.

An examination of 160 railroad trestles, of various types and length, on creosoted piling which had been driven from four to six years ago, showed some conditions which were astonishing to him. A very considerable percentage of the treated piles were of the short-leaf pine of that region. All the failures found were of this variety; no long-leaf pine had failed.

The percentage of defective piles in the structures was as follows: Driven four years ago, 13 per cent; driven five years ago, 9 per cent; driven six years ago, 18 per cent. The failures ranged from a state of decay which indicated that the pile would not last another year, to a condition where the decay was so complete that a prod could be pushed clear through the pile, once the shell was punctured. The decay was greater than that occurring in a good quality of untreated oak piles. Oak costs about 15 cents per foot, pine costs about 6 cents and treated pine about 30 cents.

An attempt to trace the cause leading to these failures developed the following information: At the plant where these piles were treated it is the custom to pile the untreated timber in open air, in piles up to 30 feet high. I saw no piles that high, but was told that sometimes they were so piled. The treating goes on at all seasons, and in all kinds of weather. There are times in Louisiana when the rainfall is so great that short-leaf pine lying in such piles would become so water logged as to make it doubtful if any treating solution could be injected into them.

Following the matter further, a pile said to have been taken from the bottom of one of the piles and which had been out of treatment but a day, was bored into about eight feet from the large end. Water began to ooze out of the hole before the heart was reached. When the auger was withdrawn quite a little water flowed, and it continued to flow, in diminishing volume, for over half an hour.

At some bridges inspected a day or two after the test above mentioned, the piles for which had been driven about six weeks, it was found that enough creosote had dripped or oozed out of the piles to perceptibly stain the ground about the base of the pile.

These facts are stated for what they are worth. It may be well to add that the failing piles were all sound as to the sap part. The defective ones were detected by sounding with a hammer. It was found that the decaying ones would all give a hollow sound.

Referring to Mr. Lounsbury's letter: Assuming that an untreated tie would cost 40 cents and last six years on the average, that it cost 45 cents to treat to resistance, and that the endurance to wear of the tie were then but twelve years, would it not pay to do it? In this part of the country it costs to put ties into the track. Wages of trackmen are $1.35 per day, and the average per man is nine ties, in ballasted track; so that it costs 15 cents per tie to do this work. This cost should be added to the two-tie job, making it cost $1.10 ($.40 + .40 + .30$), where it will cost but one dollar ($.40 + .45 + .15$) with the treated tie.

ASSISTANT ENGINEER.

(EDITORIAL FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 16, 1912.)

SOME QUESTIONS IN TIE TREATING ECONOMICS.

The discussion in these columns of questions relating to tie and timber treatment, as it is actually worked in practice in this country, continues to bring out interesting opinion and experience. In this issue we publish a letter from an engineer who has recently encountered some remarkably faulty work in creosoted bridge piling, from which it would appear that the explanation for the shallow penetration of the antiseptic was the wet condition of the timber at the time of treatment. The objection to the treatment of timber in that way is, in effect, equivalent to that of treating unseasoned timber.

It is well that this information has been brought out, for timber storage at treating plants is usually, if not always, in the open air, and while the annual rainfall in Louisiana is known to be heavy, there are other parts of the country in which timber treatment is carried on where there are heavy rains occasionally, and sometimes, even, there are periods of long-continued rains. In view of the fact that artificial seasoning of timber by steaming and vacuum, previous to the injec-

tion of the antiseptic, has been largely discontinued in this country, and that seasoning in dry kilns is not practiced at all, this matter of rain-soaked timber is one worthy of careful consideration. It is not to be presumed that a treating plant in full running would be closed down to await the air drying of timber after some days of wet weather, and, still, it can hardly be denied that a water-soaked tie or pile in a treating cylinder, without means for removing the water, comes within the classification commonly described as "refractory."

While the top layers of a pile of ties may be arranged to shed rain water, to some extent, nevertheless a hard or driving rain will penetrate a good many ties in the top and sides of the piles, making it possible for a considerable number of wet ties to find their way into the treating cylinders. If kiln drying or steaming and vacuum were practiced the rain water might not be so objectionable. The situation where ties had become rain-soaked and frozen, as is quite liable to happen in cold weather, has already been referred to in these discussions.

It is well enough to bear in mind, what is true in other industries besides that of timber treating, that commercial exigency is often antagonistic to the most efficient result in the product, and the question of artificial seasoning of timber, as well as the proper period to be allotted to air seasoning, might be considered in this light. In discussing this matter of air seasoning of ties piled in the yards of treating plants, a roadmaster recently said to us that, while it was the standard practice of his company to specify that the ties should be air seasoned at least nine months before treatment, in piles specially arranged to facilitate circulation of air about the ties, this rule was nevertheless frequently ignored and, to his knowledge, ties were often treated in less than a month from the time they were received green from the forest. In this he had reference to a plant owned and operated by the railroad which used the ties. He went on to explain that the tie supply was so irregular that it would be impracticable to air-season all of the ties the required length of time before treatment, without occasionally shutting down the plant for a considerable period, and, "of course," said he, "we would not think of doing that."

In regard to figuring the economy in treated ties, from first cost, cost of treatment, cost of laying in the track, etc., to which Mr. Lounsbury and our present correspondent refer, both of these gentlemen have failed to take into account a very important question which should not be overlooked in the economics of this subject, and that is the disturbance of the beds of the ties when renewing them, and the amount of surfacing and tamping which is required to bring the track to its original condition of support after tie renewals have been made, each year. There is nothing new about this point, for it is appreciated by many students of track maintenance, but frequently it seems to be overlooked by computers who are more familiar with the chemistry of antiseptics and the operation of treating plants than with the work of maintaining ties in the track. All that need be said

is that when a tie is taken out of the track a good deal of its bed or foundation comes with it, and this bed is seldom, if ever, restored, to afford the new tie an adequate bearing, at the time the new tie is laid. In order to re-establish this condition of support, so that the new tie can do its full share of work in supporting the rail, a good deal of tamping must be done, at different times, and this costs money.

The practical effect of renewing ties in the track is a good deal like tearing up a well-constructed macadam pavement, as is frequently done in cities to lay water or gas pipes. In constructing such pavement there is much rolling and consolidation of materials, but once the foundation is disturbed a great deal of ramming and puddling must be done to prevent local settlement and ugly-looking street surface, so often in evidence after pavement has been cut through and undermined by the sewer or the gas diggers. Precisely the same principle applies in renewing ties. We have known of instances where the section forces labored hard to get the track into smooth surface early in the season. After the tie renewals had been made it seemed as though the previous work had been done for naught, all because the work of tie renewing had not been promptly and repeatedly followed up with the tamping bar.

(FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 23, 1912.)

THE SHELL GAME IN TIMBER TREATMENT.

Editor, Railway and Engineering Review:

In the issue of the Railway and Engineering Review for November 2, I notice an editorial article entitled, "The Shell Game in Timber Treatment." In this you are just a trifle unfair to the majority of wood preservers, in that you intimate that creosoting, as a rule, is poorly done.

The fact that the anonymous engineer found that some timber in his bridges had begun to decay so rapidly rather indicates that the engineer in question did not prepare specifications for treatment intelligently. The chances are that he specified about 12 pounds of creosote per cubic foot of timber and gave no consideration to the varying sizes to be treated. Any one with the slightest engineering ability could readily understand that the amount of creosote required to give a satisfactory penetration per surface inch in a 12x12-inch timber would not be sufficient in treating six 2x12-inch timbers, although the cubic contents remained unchanged. To illustrate this point:

A block of wood 12x12x12 inches has a surface area of 864 square inches. By dividing this block into six equal parts the surface area is increased to 2,304 square inches. If 12 pounds of creosote per cubic foot gave just barely enough penetration in the 12x12x12-inch block, would it be fair to assume that 12 pounds would be sufficient to give

an equally good penetration in six 2x12x12-inch blocks? Treatment under such a system is often necessarily a "shell game." Until creosoting is put upon a sound basis through the adoption of "surface area" treatment, the "shell game" will persist as an ever-present evil.

A. B. C.

[We are not aware that in the editorial above referred to, or in any other discussion of timber treatment, we have intimated that creosoting, "as a rule, is poorly done." We have referred to some of the work of creosoting that had been poorly done, in different instances, but do not find that our remarks have assumed or intimated that even the larger part of creosoting work was of inferior quality.

The correspondent raises an interesting point over the difference between the use of a stated quantity of creosote per cubic unit of timber treated and depth of penetration per surface unit. A penetration of one inch in treating the six 2x12x12-inch plank, which he used for illustration, would impregnate the cubic foot of lumber through and through, while the same penetration of a 12x12x12-inch block would come far from through impregnation and require much less creosote; and yet the cubic volume of timber treated is the same in either case.—Ed.]

(FROM RAILWAY AND ENGINEERING REVIEW, NOVEMBER 30, 1912.)

THE SHELL GAME IN TIMBER TREATMENT.

Editor, Railway and Engineering Review:

In your issue of November 23 Correspondent "A. B. C." takes some exception to the remarks from my letter which you quote. He is none too strong when he speaks of my ignorance on this subject. However, I can prove an alibi in this case, as I had nothing to do with the treating, or driving of these piles. However, as it may be of interest, I will say that some of the methods used may have had much to do with the failure of the work. These piles were commercially treated. The quantity of preservative used is not known to me. The piles were what is called "loblolly" pine. They were driven with a common hammer, used without a follower. They bruised badly under the hammer, and may not have been well driven. It was the custom, after sawing off the pile to "paint" the top and all parts which were cut in framing, with pure creosote oil. It is not for me to criticize the work. The men in charge are men for whom I have the greatest respect.

I do not know that this was good practice, but it was not such as has been the practice on work that I have been connected with. But if these men, capable and reliable, have made an error, is it not well that the result of such error be made known as widely as possible? I do not wish to pose as having wide knowledge. I do wish to learn. I have been enlightened by what others have written. A railroad 350 miles in length cannot have its own plant for this work. Its chief engineer may not be too positive as to what should be done, and the cheapness of some method claimed to be "just as good" may have weight with the president and the board. Will it enlighten them for "A. B. C." to accuse me of incom-

petency? There is one clear fact. The creosoted piles under a ballasted-deck bridge, supposed to be a permanent structure, are failing. I asked the editor for some light, and from his personal letter, the literature he referred me to, and the later letters, I am getting some light.

Now, for another question: It has been suggested to me that we have a hole bored eight feet deep into the large end of each pile before treatment, and that later this hole be filled with oil and plugged. I would be glad of suggestions and criticisms on this.

Building a ballasted-deck bridge of treated piles and timber adds very largely to the cost. We should endeavor to get adequate life for the structure. ASSISTANT ENGINEER.

(FROM RAILWAY AND ENGINEERING REVIEW, DECEMBER 21, 1912.)

ESSENTIALS FOR EFFECTIVE WORK IN TIMBER TREATMENT.

Cleveland, Ohio, December 9, 1912.

Editor, Railway and Engineering Review:

The editorials and correspondence appearing in the five November issues of your paper are truly interesting and instructive. These discussions are certainly of the right kind to disseminate knowledge on a subject which, I regret to say, has been entirely too much wrapped in mystery and in secrecy, for the common good. I esteem the course you are pursuing in your endeavor to improve the methods of treating ties and timber, and I trust you will continue to bring out information for those who are conscientiously seeking it, and will not hesitate to strike a blow at poor creosoting work wherever done, no matter whether the stroke falls upon commercial preservers, or upon the railroad official who would authorize poor work done, or upon any one who in some way connives with practitioners who are doing poor work.

Examples of poor work, such as were reported to you by "Assistant Engineer," are not uncommon. I have seen railroad ties which were thoroughly saturated with creosote oil break to pieces when rolled off the cars, the interior being completely rotted. I have seen thousands of creosoted hardwood ties that had a penetration of less than ½-inch or only "shell deep." Any one who might be disposed to doubt this statement need only examine some of the creosoted ties distributed along the railroads that have them treated by the partial-dose processes, to be convinced of the truth of my statement. It will be noticed that in many instances, when some of the ties are adzed for rail bearing the creosoted wood is nearly all chopped away and the rail and tie plates rest upon untreated wood. Is there any one so blind and prejudiced as not to perceive that such creosoting work is bad policy? Is there not a remedy? Certainly there is. I will explain.

The poor work can be attributed mainly to two causes, namely: (1) Ties, poles or timbers of any kind not being properly and sufficiently seasoned or dried before the injection of the preservative; and (2) the ties, piling or timbers of any kind being treated with only a limited quantity or partial dose of creosote oil.

In treating timber of any kind it is first necessary to extract the sap and water from the wood before the injection of the fluid. Water-logged or green timber, with its natural saps and its sap cells in their normal condition, will resist the introduction of any fluid, on the principle that two bodies cannot occupy the same space at the same time. To be able to introduce any solution the natural saps and water in the timber must be in some way removed. The absorption depends, in a very large degree, upon the dryness of the wood; the drier the wood the greater will be the absorption and dissemination, consequently the better the treatment.

The common practice at treating plants in this country is to stack the ties in open air for from three to twelve months, depending upon the kind and character of wood, climatic conditions, etc., until the moisture in the ties has evaporated sufficiently for reception of the preservatives. Piling and timbers are seasoned in a similar manner, but for a longer period. This is a very slow, crude and uncertain method. The seasoning is very unequal and erratic, some pieces retaining more moisture than others, and the impregnation is much influenced thereby.

Another method is to boil the timber in live steam, in the impregnating cylinders, just before the injection of the preservative, in order to force out the saps and water in the timber, by heating, loosening and expanding the same into vapor and breaking the cell walls to admit the introduction of the preservative fluid. This method is not altogether satisfactory, as the cells are full of vapor and water which resist the entrance of the preservative fluid. A fair penetration can be obtained by this process with zinc chloride—a water solution—but scarcely any with creosote oil. Several plants in Oregon and Washington employ the method of boiling the tie and timbers in creosote oil, which produces a similar effect on the wood as the boiling in live steam.

For thorough treatment, it is absolutely essential that all saps and water be removed from the wood, so far as possible, before the injection of the fluid, and this can be effected quickly and economically by means of steaming cylinders (separate from the impregnating cylinders) and drying ovens or kilns. The timber should be steamed as soon as possible after it is converted into ties, or piling, or dimension stock of any kind, so as to extract the sap and break the cell walls of the wood. After steaming, the material should be piled or stacked in the open air for seasoning. The evaporation of the vapor and water in the wood will be rapid and a much shorter period will be required to season the wood than when the preliminary steaming is omitted; and that will depend upon the character of the wood, climatic

conditions and several other factors that influence the rate of evaporation. When sufficiently seasoned the material should be loaded on trams and introduced into the drying ovens where the drying can be completed in 12 to 36 hours, or an average of 24 hours. While the timber is hot, dry and in prime condition to receive the hot preservative it should be transferred from the ovens to the treating cylinders quickly, so as to lose as little of the heat in the wood as possible. The ties should be machined, that is, adzed and bored, just before they are placed in the ovens, and it is also advisable, before the treating is applied, to shape the timber to the form in which it is to remain.

When ties, piling and timbers are introduced into the impregnating cylinders, in a thoroughly dry and heated condition, and the hot preservative fluid is applied, the fluid is readily absorbed and the penetration is deeper and better diffused than when they are not thus prepared. The condition of the timber as regards moisture content is by far the most important of many factors influencing the absorption of the preservative, and unless this feature be given proper attention, the results from treatment will hardly ever be satisfactory.

The second requirement for good treatment is the injection of the preservative into the wood to total refusal, instead of in a specified quantity, such as six, eight, ten or twelve pounds of creosote oil, or six, eight, ten or twelve ounces of zinc chloride salt, per cubic foot of timber, as is frequently stated in specifications. The strength of zinc chloride solution should be specified, but not the quantity of salt per cubic foot. In all cases the preservative should be injected to refusal, regardless of whether creosote oil, zinc chloride, crude asphalt oil, or any other solution or mixture, is employed.

It is a common practice in treating ties or timbers with creosote oil to stop the operation or injection when the requirement as to quantity is met and before the receptivity of the timber is exhausted. This is manifestly wrong, and specifications which limit the quantity of oil or salt per cubic foot of timber are faulty. When the timber is waterlogged or green it is sometimes difficult, if not impossible, to inject even the minimum quantity thus specified. It is common to find specifications for creosoting piles or timber calling for an eight, ten, or twelve-pound treatment. In such specifications there is room for deception. I will explain.

In treating timber under pressure there is always a rebound of the fluid, when the fluid pressure in the cylinder is released. This rebound or "kick back," as some call it, varies with many conditions, such as character, density and moisture content of the timber, contraction of volume of creosote, expansion of the cylinder due to temperature, expansion of the wood, etc., and amounts sometimes to as high as 40 per cent. of the amount actually injected into the wood. It is estimated that out of a total specified injection of 10 pounds per cubic foot, or 35 pounds per tie, 8.7 pounds per tie may be forced into the cylinder, but either will not go into or not remain in the ties, thus

constituting a total error of about 25 per cent.* Thus while the "recording gage" clearly indicates that a 10-pound treatment was applied, as specified in the contract, and for which the customer is supposed to pay, yet he actually gets only 7.5 pounds of oil per cubic foot in his timber. The "rebound" or "kick back," which always takes place when treating under pressure, and which, on an average, we estimate, amounts to nearly 25 per cent. of total injected in the timber, is what the "empty cell" creosote process workers allege to withdraw from the wood by means of an "initial pressure" or a "final vacuum." The physical laws of nature, however, operate the same for everybody and the "rebound" will occur, no matter whether that natural phenomenon is patented or not.

As you have properly stated, in one of your editorials, there is only one safe course to pursue, and that is to work the pumps to downright refusal of the timbers to take more of the solution, no matter whether the preservative is creosote oil, chloride of zinc, crude asphalt oil, chemicals or mixtures of any kind. Thorough impregnation is of first importance, and the quantity and cost of the preservative is of secondary importance. The quantity of preservative absorbed by the material is easy to determine, and the cost of the same can be definitely ascertained after the completion of the treating operation.

Shallow penetration has resulted mostly from the use of patented creosote processes. In order that the cost of treating ties and timbers by these processes, with creosote, would not exceed too much the cost of treating ties and timbers with zinc chloride, or asphalt crude oil, to refusal, the idea was conceived of injecting only a limited quantity of creosote oil into the wood; and it has been claimed that it was "just as good." The dose was fixed at 2 to 2½ gallons per tie, equivalent to five to seven pounds per cubic foot of timber. It is also represented that, by means of segregating the timbers into groups, according to species, density, moisture content, etc., no less than 95 per cent of the ties will receive "uniform and thorough" treatment. This claim has been absolutely disproved by the experiments at Shirley, Indiana, and Toledo, Ohio, which were published in your paper, August 3, 1912. It was found that the variation in absorption was very large, some ties getting but very little oil, while some received considerably more than the average quantity.

The partial-dose advocates advance another reason for not treating ties to refusal. According to their theory and assumptions, to inject into the timber all the creosote oil it will receive might preserve it so well against decay that it would "outlive its usefulness." You have so ably and so thoroughly discussed this question that there is little or nothing for me to say. The balancing of "mechanical life" with the "chemical treatment life" is a favorite argument with these partial-dose advocates, and when all of their theories are proven wrong or impractical and there is nothing more to offer in support of their claims, they advance that

*Authority, Forest Service Bulletin 118, U. S. Dept. Agriculture, November, 1912, Page 33.

vague argument. They talk learnedly about "mechanical life," "mechanical abrasion," "mechanical wear," and repeat these technically-sounding terms as though they had, by common acceptance, an established meaning. Truly, I am glad you have extended an invitation to readers to tell us something definite about the "mechanical life" of ties. This question admits of answers that would be about as definite as it would be possible to give to such ones as "How long is a stick?" "How tall is a tree?" "What is the ratio between the length of a stick and the height of a tree?" Furthermore, were it possible to determine the mechanical life of ties with any degree of accuracy, expressed in years, under all traffic conditions and for all kinds of woods, can any one tell us what the "chemical life" of ties would be, expressed in years, treated with various preservatives and in different quantities?

Before we can do any intelligent "balancing" we should know something definite about both sides of the equation. The next time any speaker or writer presents this "mechanical life" argument we trust he will confer the favor of stating specifically the ground upon which he bases his assumptions, and not be "like unto the man on a bald butte, talking to the wind."

Decay and mechanical wear are so interwoven and interdependent that it is manifestly impossible to determine the ratio of these two destructive elements. The destruction is due to their combined action and cannot be separated.

In conclusion, I give the following summary and recommendations:

1. Ties, piling and timbers should be thoroughly seasoned or dried by artificial process, consisting of steaming, open air drying and oven or kiln drying.

2. Ties, piling and timbers should be treated to refusal, with whatever preservative the user or customer demands.

If these recommendations are followed the number of complaints of poor work and malpractice will diminish, and the "shell game in timber treatment" will not be so much in evidence.

W. F. GOLTRA.

Some Facts

About

Treating Railroad Ties

Parts IV, V, VI

By

W. F. GOLTRA

PRESIDENT, THE W. F. GOLTRA TIE COMPANY

CLEVELAND, OHIO

1913

CONTENTS.

Page

Preface 5

PART IV.

A Comparison of zinc chloride with coal-tar creosote for preserving cross-ties, by Howard Weiss..... 11

Discussion of Mr. Weiss' paper by W. F. Goltra..... 23

PART V.

History of Wood Preservation by W. F. Goltra..... 35

PART VI.

Timber-Treating Plants in North America Dec. 31, 1912, by W. F. Goltra..... 61

Map showing Forest Regions and location of Timber-Treating Plants in North America..... bet. 66 and 67

Preliminary treatment of timber to insure a more even and satisfactory imprenation with creosote by David Allerton..... 85

Comments on Mr. Allerton's paper by Mr. Goltra..... 86

Advertisement of "Some Facts about Treating Railroad Ties..... 88

PREFACE TO PARTS IV, V and VI.

In the following pages the author presents a discussion of wood preservation in Europe and America and a list of wood preserving plants in North America. The greater part of this material was prepared for the American Wood Preservers' Association and has been printed in the Proceedings for the year 1913.

There was considerable objection to the printing of the author's discussion of Mr. Weiss' paper by some members of the Association. These men argued that the statements, which were made in rebuttal of Mr. Weiss' argument, might have ill effect upon the timber-treating industry as a whole and do injury to the Association; but, in fact, it was a subtle trick, which has been successfully worked before, to hide their infirmities and deficiencies. After careful consideration, the Executive Committee concluded that the remarks were admissable and authorized the printing of same in the proceedings.

Many problems in the art of treating wood with antiseptics have yet to be solved and there is undoubtedly much room for improvement. Many years of experience, exhaustive study and close observations of the methods employed in timber treating, both in this and foreign countries, persuade the author that the greatest improvements in the present methods employed lie in the direction of a speedier and more efficient method of seasoning the timber, a more thorough preparation of the timber for receiving the injection of the antiseptic and a greater economy in the handling of the material in process of treatment, by means of modern equipment and appliances.

A majority of the timber-treating plants, both in America and Europe, are treating ties and timbers by the same methods and in the same manner as was practiced a half a century or more ago. This consists of simply placing the timber to be treated in air-tight cylinders and submerging the wood in a preservative fluid and then forcing more liquid into the wood by means of force pumps. Some modifications of this primitive method have been tried and recommended and some improvement has been accomplished, but it has been slow, because in a majority of cases the experimenters and practitioners confined themselves closely to the method invented by Sir William Burnet and Mr. John Bethell, of England, in 1838, and any departure from these two established methods was made with diffidence.

Development and improvement in the timber-treating industry has, therefore, been comparatively slow. It has hardly kept pace with that in several other industries of similar character, and there are reasons for this. Aside from diffidence in adopting new methods, there have been, and there are now prevailing, baneful influences which tend to hinder and retard the development and im-

provement in this important industry, but with the acquisition of a better understanding of the fundamental and underlying principles governing timber treating, these will eventually disappear.

There are some honest people in the wood-preserving industry, there are some of them that do good work and a lot of them that mean to do good work, but there are in this business, as in any other, people who are not doing honest work. It is a curious fact that in all ages, mountebanks have posed as masters and teachers. The world is full of the story of the impostor, the false teacher and the bogus reformer. The timber-treating industry has not escaped the wiles of the fakir and the impostor.

Unscientific and unscrupulous "shell gamesters," peddling worthless processes, have infested the field. By means of "long term" contracts with some of our railroads, **awarded without competition,** several of these treating companies are enjoying special privileges. As the late Samuel Rowe once remarked, "The fakir must have his day, but it will be a short day, and when it ends not only will he get his deserts, but those who he misled, innocently on their part, will have cause to mourn." The author still pledges his best efforts and will not hesitate to interpose when dishonest practices prevail and when the simple incentive is the "money there is in it."

It should be borne in mind that some of these people, who are so industrious and vigilant in suppressing information and knowledge regarding the principles of timber treating, in order to keep the uninitiated ignorant of the facts, have ulterior motives. There is danger that their trade will fall into disrepute. In this they are not unlike certain idolatrous Athenians of old, mentioned in the Holy Scriptures. St. Paul said to them, "We ought not to think that the God-head is like unto gold, or silver, or stone graven by art and man's device." This kind of preaching caused no small stir in that community of idolaters, for a certain man named Demetrius, a silversmith, who made silver shrines of Diana, that brought no little business unto the craftsmen, whom he gathered together with the workmen of like occupation, said, "Sirs, ye know that by this business we have our wealth. And ye see and hear that not alone at Ephesus, but almost throughout Asia, this Paul hath persuaded and turned away many people, saying that they be no gods which are made with hands, and not only is there danger that this our trade come into disrepute, but also that the temple of the great Goddess Diana be made of no account and that she should even be deposed from her magnificence, whom all Asia and the world worshippeth."

And when they heard they were moved with wrath and cried out, "Great **is** Diana of the Ephesians." There was great confusion in the assembly. The mob laid hold of two of Paul's followers and was about to make away with them when the town clerk

quieted the crowd by saying: "Ye ought to be quiet and do nothing rashly. Ye have brought hither these men which are neither robbers of churches nor blasphemers of your Goddess. Wherefore, if Demetrius and his craftsmen which are with him have a matter against any man, the law is open and there are deputies; let them implead one another. There is no cause for riot." And thus having spoken he dismissed the assembly.

The exponents, exploiters and defenders of bogus treating processes and some dealers in certain preservatives that are not what they are represented to be, have in many ways attempted to suppress and conceal all facts that would shed any light on their questionable methods. Such revelations would operate against their private interests. Their attitude is well expressed in the words of the Hoosier poet, "They seen their duty and they did their damdest, angels could do no more." But in spite of their opposition and machinations, the people are awakening to a realization of the true state of affairs.

As with the idols of the Athenians, the people will in due time realize the frauds and impositions upon their credulity and abolish these antiquated processes. Some of the writer's opponents are fearful that what he says might upset or depose some of the old idols in timber treating and do injury to the cause. There is no need for worry in that respect. The timber-treating industry, like the Christian religion, is established on a firm and enduring foundation and has a honest and needful purpose; and it will continue to grow and bestow its beneficence upon mankind, regardless of what anyone can do or say. In due time most of the imposters, grafters and "shell gamesters," like the idolaters, will be converted and gradually "fall in line" with the procession which makes for progress and honest business methods.

Special privileges and private favors stifle competition and thereby a favored few are enabled to corner the business. This naturally retards and hinders the development of the industry. Cutting out these cancers of privilege would excite competition in efficiency and permit the development of more modern methods. It would serve, not the greedy special interests, but instead the general welfare.

The ideal of American democracy is **equal opportunity for all, special privileges for none**. Quoting President Wilson in his first message to Congress, "We should abolish everything that bears even the semblance of privilege or of any kind of artificial advantage, and put ourselves under the stimulation of a constant necessity to be efficient, economical and enterprising, masters of competitive supremacy, better workers than any in the world."

THE AUTHOR.

PART IV

Comparison of Zinc Chloride and Creosote for Preserving Cross-Ties

A COMPARISON OF ZINC CHLORIDE WITH COAL-TAR CREOSOTE FOR PRESERVING CROSS-TIES.

By Howard F. Weiss.

Although a great many preservatives have been tested to preserve cross-ties, zinc chloride and coal-tar creosote are now by far the ones most extensively used in the United States. The author has frequently been called upon to compare these two preservatives; in fact, the number of such requests has been so large that it has led to an examination of the merits and deficiencies of each preservative. This paper aims to present the information which has thus been collected and to invite discussion. Please, note, however, that only cross-ties are considered, and the data which follow should not be confused with poles, piling or other products.

According to statistics gathered by the Federal Government, the number of cross-ties treated with zinc chloride in the United States shows no increase in the past four years, while the number treated with creosote has increased rapidly. (See Table 1.)

Table 1.—Number of Ties Treated With Zinc Chloride and Creosote in the United States.

Preservative.	Year.				
	1907	1908	1909	1910	1911
Zinc chloride ..	9,864,765	8,640,230	8,051,054	9,195,861	9,445,961
Creosote	5,750,874	9,620,420	9,943,360	14,841,843	16,510,721

This in itself might be looked upon as an answer to the query: "Which is the better of the two?" But after a careful investigation it appears that this question can not be so easily dismissed. I asked twelve leading operators of wood-preserving plants their opinions why the number of ties Burnettized in this country did not increase. Their replies group themselves as follows:

(1) Poor workmanship in Burnettizing, either through ignorance or otherwise.
(2) The zinc leached from the ties, or the railroads fear that it would.
(3) The salesmen of coal-tar creosote are more industrious than the zinc salesmen.
(4) Zinc-treated ties cause trouble with the automatic signal apparatus.
(5) The empty-cell creosote processes reduced the initial cost of treating with creosote.
(6) Railroads consider creosote cheaper in the long run, and because ties are growing scarcer they want to give them the treatment which make them last the longest.
(7) Railroad engineers have concluded that zinc chloride has a tendency to corrode spikes.

(8) Tie treatment is now largely east of the Mississippi, where the climate is moist, while Burnettizing began west of the Mississippi, where the climate is dry.

(9) Heavier tie-plates are now being used, warranting a more permanent preservative treatment.

These replies are very instructive and certainly worth careful thought.

The factors which I have considered in comparing the two preservatives under discussion may be grouped as follows:

(1) The toxicity of the preservative—namely, its ability to prevent decay.
(2) The ability of the preservative to penetrate the tie.
(3) The permanency of the preservative in the tie.
(4) The effect of the preservative on the strength of the tie.
(5) The effect of the preservative on the corrosion of spikes and plates, and the operation of block signals.
(6) The financial saving due to the use of the preservative.

Of somewhat lesser importance are:

(7) The uniformity in composition of the preservative and ease of securing it.
(8) The combustibility of the preservative.
(9) The ease of handling the preservative and ties treated with it.
(10) The ease with which the penetration of the preservative can be determined.

Toxicity of the Preservative.

Zinc chloride relies upon its toxic properties solely to protect ties from decay. Creosote, in addition to this, has a more or less waterproofing effect, which also acts as a protection against decay. According to the toxic tests made by Malenkovic, zinc chloride offered about twice the resistance to fungous attack (penicillium) as coal-tar creosote free from phenol. Tests made at the Forest Products Laboratory showed that ordinary coal-tar creosote had about the same toxicity as zinc chloride, four-tenths per cent being sufficient in each case to prevent fungous growth (Fomes annosus).*

The Ability of the Preservative to Penetrate Wood During Treatment.

In the author's opinion, this is a feature of tie preservation which is given, in practice, too little consideration. All toxicity data show that both zinc chloride and coal-tar creosote are powerful fungicides, and that small quantities of them will inhibit decay. It is good practice, therefore, to diffuse the preservatives thoroughly through the tie so that as many of the wood cells as possible will be poisoned. A tie might contain ten or twelve pounds of creosote

*These tests were made by the Petri dish method, in which the culture medium was made of juice from 1 pound of beef, 25 grams of Lofflunds malt extract, 20 grams of agar agar and 1,000 cc of distilled water. A 1 per cent solution was figured as 1 gram of preservative in 100 cc of culture medium.

per cubic foot and yet be poorly treated if the oil is not well diffused; in fact, not nearly as well preserved as a tie having only four or five pounds of the oil per cubic foot, but with the oil uniformly and deeply distributed.

It is well known that water solutions will penetrate wood more easily and thoroughly than oils; for example, in making what are called the "penetrance tests" at the Forest Products Labratory it took about three minutes to force zinc chloride solutions through 6 inches of hemlock parallel to the grain, while creosote took over 30 minutes. Again, under simliar conditions in treating red oak and maple ties we forced about 50 per cent more by volume of zinc chloride solution into them than we did coal-tar creosote. Any process which aims to impregnate ties with only a certain amount of preservative irrespective of the penetration secured is, in the author's opinion, operated on an incorrect basis; and any specification which will enable ties to be treated in this manner is a poor specification. In treatments with zinc chloride I believe a strong preliminary vacuum should be drawn, and the solution admitted to the cylinder without breaking the vacuum, after which pressure should be applied and held to "refusal." The absorption of dry salt can then be controlled by varying the concentration of the solution rather than by varying the amount of solution forced into the ties. Unfortunately, this simple treatment can not be used with creosote (except with certain resistant ties) because too much oil would be absorbed and the treatment would become too expensive.

The Permanency of the Preservative in the Tie.

Permanency, as applied to preservation, involves two phenomena: (a) volatilization; (b) leaching.

Zinc chloride under conditions of use is non-volatile. Creosote, on the other hand, evaporates from the tie. The rate at which it evaporates depends on many conditions, such as its composition, method of injection, atmospheric conditions during seasoning, etc. The following examples are given to illustrate such evaporation:

(1) Some North Carolina pine poles creosoted according to the American Telephone and Telegraph Company's Specification No. 367, and set in 1897, were removed about nine years afterward and the oil in them examined. About 57.1 per cent of the original oil in the top and about 37.5 per cent in the butt of the pole was lost almost exclusively through evaporation during this period.*a*

(2) Ties creosoted by the Rueping process in Texas and

---

a Von Schrenk, Fulks and Kammerer. Proceedings A. R. E. and M. of W. Association, Volume 9, page 738.

piled to air season lost from May 12 to October 28 from 40 to 60 per cent. of the creosote injected. Ties treated by the straight creosote process lost in the same time 20 per cent.*b*

(3) Red oak ties treated by the full-cell process lost in 200 days (November, 1910, to June, 1911,) about 19 per cent of the weight of preservative injected. When similar ties were treated by an "empty cell" process the loss in the same period was about 52.7 per cent. Maple ties treated by the full-cell process lost in 105 days (March to June, 1911,) 13.4 per cent of the weight of creosote injected. When similar ties were treated by an "empty cell" process they lost in the same time 23 per cent. As these ties were all air-seasoned and at approximately the same moisture content, little of this loss can be attributed to evaporation of water*a*

This objection to creosote has led in some cases to mixing it with tar, the idea being that such a mixture will hold in the tie the more volatile constituents of the oil. It is quite probable that tar will do this, but there are strong objections to such practice, and it is the author's opinion that its adoption should take place only after much more convincing data than we now have been obtained.

Creosote is practically insoluble in water, while zinc chloride is readily soluble. The solubility of zinc chloride may be illustrated by the following examples:

(1) Twelve Burnettized lodgepole pine ties were sawed in two. One-half of each tie was placed in the water for 24 hours, at the end of which period the amount of salt leached out was determined and the half ties allowed to dry for 24 hours, when they were again submerged. This was continued for several days. The second half of each tie seasoned until air dry was then ultimately submerged and dried just as the first ties had been and the amount of salt leached out determined. The results are given in Table 2.*c* If the ties contained originally .5 pound of dry zinc chloride per cubic foot the per cent of loss for the freshly-treated ties at the end of the sixth period would be 40 per cent and for the seasoned ties 32 per cent.

---

b Report by A. M. Steinmayer to E. O. Faulkner, dated October, 1905.

a Forest Service Bulletin 123, by F. M. Bond. Moisture percent of red oak ties treated by full-cell process at time of treatment equaled 45, and by the "empty cell" process 45.7. Moisture per cent of maple ties treated by the full-cell process at time of treatment equaled 32.4, and by the "empty cell" process 31.1. These ties were treated as follows:

Full Cell Process.—Ties run into cylinder and submerged in creosote at 170° to 190° F. under a maximum pressure of 175 pounds per square inch until an absorption of approximately 12 pounds per cubic foot was obtained. Oil then run from cylinder and a final vacuum of 26 inches held for 30 minutes to dry ties, after which they were removed from the retort.

Empty Cell Process.—Ties run into cylinder and air pressure applied (50 pounds per square inch for red oak; 90 pounds per square inch for maple) for at least ten minutes. Creosote then pumped into cylinder at 170° to 190° F. against this pressure, releasing excess of air but maintaining pressure. When the cylinder was filled with oil the pressure was raised (140 pounds per square inch for maple, 175 pounds per square inch for red oak) and held to refusal (viz: until the measuring tank gauge showed no further absorption in two successive readings of 15 minutes interval), after which the cylinder was drained of oil and a 26-inch vacuum held for 30 minutes, when the ties were removed.

c Bulletin 41, Bureau of Forestry, Herman von Schrenk, page 15.

Table 2.—Amount of Zinc Chloride Leached from Treated Lodgepole Pine Ties.

	Amount zinc chloride (grams leached out during)						
	First Period	Second Period	Third Period	Fourth Period	Fifth Period	Sixth Period	Total
Freshly treated ties.	585	318	306	226	205	201	1841
Seasoned ties.....	677	352	154	109	122	62	1476

(2) Small pieces of hemlock impregnated with about .5 pound of dry zinc chloride per cubic foot were soaked without subsequent air seasoning in distilled water for 30 days and the water analyzed. In the first five days about 46 per cent. of the salt had leached out, and in 30 days about 62 per cent. This, however, was an exceedingly severe test.*a*

(3) Forty-eight ties of Douglas fir and lodgepole pine injected with one-half pound of dry zinc chloride per cubic foot were submerged in water for 24 hours and dried about 7 days, an analysis being made, and the ties again submerged. This was repeated about forty times, covering a period of over 300 days. During the first 70 days approximately 18 per cent of the original amount was lost, and at the end of 300 days the total loss was 25.5 per cent *b*

From tests made in the Forest Products Laboratory it appears that certain amounts of zinc chloride can not be leached out of wood even by very severe soaking. Just how much of the zinc chloride thus remains is not known to the author, but tests on this point are now under way at the laboratory. It is claimed that the leaching of zinc chloride in ties can be retarded by air-seasoning them after treatment, or by coating them with an oil. I have no conclusive data on either of these claims.

Effect of the Preservative on the Strength of the Tie.

With decay largely eliminated from properly preserved ties, and with the tonnage of our roads constantly increasing, the problem of prolonging the life of ties from rail and spike cutting is becoming more and more acute. Obviously, a preservative which will decrease the strength of ties when injected will be subject to serious criticim. Tests made by the Forest Service some six years ago on loblolly pine ties indicate that the presence of zinc chloride did not weaken the wood under static loading, but tended to make it brittle under impact, while no decrease in strength was noted for ties treated with creosote.*c* Tests made since then indicate that both preservatives weaken the wood, although, if *properly injected,* the weakening thus caused is too small to be of practical importance. In one case a decrease of 40 per cent in the bending strength of wood creosoted by a commercial plant was, however, observed.

a Volume 13, page 279. Eighth International Congress of Applied Chemistry, Howard F. Weiss.
b Proceedings New York Railroad Club, Feb. 18, 1910, F. J. Angier.
c Circular 39, Forest Service, by W. K. Hatt.

The Effect of the Preservative on Corrosion of Spikes and Plates and the Operation of Block Signals.

Some pieces of flange steel of equal dimensions, weight and quality were immersed, respectively, in coal-tar creosote and a 6 per cent solution of zinc chloride for three weeks and constantly heated at 98° Centigrade. At the end of this time the steel in the creosote lost .0064 gram, while that in zinc chloride solution lost 1.4636 grams. Of course this was a very severe test, not comparable to what takes place in the track; but even at atmospheric temperatures the corrosion of steel spikes and plates in contact with zinc-treated ties is probably greater than with creosoted ties. Whether it is of sufficient intensity to be a real detriment is not known to the author. The concensus of opinion among those who claim experience seems to be that if the zinc ties are properly seasoned before placement in the track the corrosion is of no appreciable consequence.

The presence of zinc chloride in wood is very liable to decrease the resistance of the tie to the passage of an electric current; consequently, if the flow of current is away from the track a marked corrosion of the spikes will occur. This action may, however, take place in untreated ties, especially when wet. Zinc chloride, being deliquescent, tends to keep the ties moist, while creosote tends to waterproof them; hence deterioration of spikes subject to the passage of electric currents is more likely to take place in ties treated with zinc chloride than in those treated with creosote.

The electrolytic action of zinc chloride and creosote in ties is a subject about which much discussion has occurred, particularly in connection with the operation of automatic block signals. The most accurate tests known to me, bearing on this subject, were made by Mr. J. T. Butterfield, of Purdue University, in 1910. His tests concluded that ties treated with creosote offer greater resistance than those treated with zinc chloride, and less resistance than untreated ties, as follows:

Effect of Treatments Upon the Electrical Resistance of Ties.

Kind of Wood.	How Treated.	Ratio of resistance (treated to natural).
Loblolly pine.....	Full cell process....	0.34
Shortleaf pine.....	Full cell process....	0.79
Red oak	Burnett process....	0.16

The experiences of several signal engineers are that zinc-treated ties will cause trouble with the block signals if they are placed in the track unseasoned, or if the distance between blocks is too long. A shortening of the circuit to about 1,000 or 1,200 feet has, in many instances, remedied these difficulties.

Financial Saving Due to the Use of the Preservatives.

A discussion of all factors finally simmers down to a discussion of cost. Because of the scarcity of authentic service records generalities must still be used. The numerous test tracks now placed throughout the country will, it is hoped, furnish us with accurate data upon which to base decisions. Quoting from a report of the Wood Preservation Committee of the American Railway Engineering Association:

> "Creosoting at present can not be relied upon to preserve ties more than 15½ to 19 years, an absolute maximum, unless the ties are protected against mechanical deterioration. If badly injected they perish from decay in five to twelve years. Burnettizing, when well done, can be relied upon to preserve ties from ten to fourteen years. There are great differences in the thoroughness with which the work can be done."*

From the records quoted below we will assume that a tie properly treated with zinc chloride will last, on an average, 12 years, and with creosote 17 years, which, in an untreated condition, would last 5 years. We will assume that the cost of the tie untreated is 45 cents, the cost of creosoting 30 cents, the cost of Burnettizing 15 cents, and of placement in the track 15 cents. We then have:

Cost of untreated tie in track, 60 cents.
Cost of Burnettized tie in track, 75 cents.
Cost of creosoted tie in track, 90 cents.
Life of untreated tie in track, 5 years.
Life of Burnettized tie in track, 12 years.
Life of creosoted tie in track, 17 years.

From these values, figured at 5 per cent compound interest, we find that:

Annual cost of an untreated tie equals 13.86 cents.
Annual cost of a Burnettized tie equals 8.40 cents.
Annual cost of a creosoted tie equals 8.01 cents.

And if figured without interest:

Annual cost of an untreated tie equals 12 cents.
Annual cost of a Burnettized tie equals 6.25 cents.
Annual cost of a creosoted tie equals 5.29 cents.

From which it may be deduced that both preservatives are very economical to use in comparison with untreated ties, and of the two, creosote is ultimately slightly cheaper. Under the assumptions here taken zinc-treated ties must last about 12½ years in order to have the same annual charge as creosoted ties, while the creosoted ties must last 15½ years in order to have the same annual charge as the zinc-treated ties. The author leaves the reader to manipulate these figures in any way he sees fit, but in so doing calls attention to the records given in Table 3.

Uniformity in the Composition of the Preservative and Ease of Securing It.

The zinc chloride produced in the United States is, for a com-

*Volume 10, Part I, Proceedings A. R. E. and M. of W. Association, 1909.

Table 3—Reported Life

Species.	Laid By.	Treatment.
Beech	German Imperial Railways	Creosote
"	Germany—Union Railways	"
"	Germany, Union Railways	"
"	France—Nord Railway	"
"	Germany—Hanover Railway	Zinc chloride
"	Germany—Brunswick Railways	" "
"	Switzerland—Swiss Nord Ost Bahn	" "
"	Germany—National Railways	" "
"	Germany—Imperial Railways	" "
"	Prussia—All State Railways	Rutgers
Cedar	C. and N. W.	Wellhouse
Fir	German and Austrian Railways	Creosote
"	German and Austrian Railways	Zinc chloride
"	Switzerland—Swiss Nord Ost Bahn	" "
" (Douglas)	Southern Pacific	" "
Hemlock	N. Y., N. H. & H.	Creosote
"	Pittsburg, Ft. Wayne and Chicago	Wellhouse
" and tamarack	C. R. I. & P.	"
Oak	France—Southern Railway	Creosote
"	France—Western Railway	"
"	France—Orleans Railway	"
"	France—Paris, L. & Med.	"
"	France—General	"
"	France—State Railways	"
"	Germany—Union Railways	"
"	Germany—Union Railways	"
"	Germany—Union Railways	Zinc chloride
"	Switzerland—Swiss Nord Ost Bahn	" "
" (White)	Average from reports, 22 roads	Untreated
" (White)	C., B. & Q.	"
Pine	German Railways	Zinc chloride
"	France—Southern Railways.	Copper sulphate
"	German Union Railways	Creosote
"	German Union Railways	"
"	France—General	"
"	France—Orleans Railway	"
"	Germany—Altona-Kiel Railway	Zinc chloride
"	France—State Railways	" creosote
" (Mountain)	Union Pacific	Wellhouse
" (White)	N. Y., N. H. & H.	Tilhamy
Redwood (Baltic)	Russia—St. Petersburg	Zinc chloride
" "	Great Britain—Belfast and N. C. Ry.	Creosote
" "	Great Britain—Furness Railway	"
" "	Great Britain—Great Eastern Railway	"
" "	Great Britain—Gt. Northern Railway	"
" "	Great Britain—London, Tilbury and Southend Railway	"
" "	Great Britain—London & N. W. Ry.	"
" "	Great Britain—London & S. W. Ry.	"
" "	Great Britain—Manchester S. & L. Ry.	"
" "	Great Britain—Taff Vale Ry.	"
Tamarack	Pittsburg, Ft. Wayne & Chicago Ry.	Wellhouse

of Ties in Service.

Average Life Years	Source of Information.
19.5	Railway Gazette, Vol. 32, 1900, p. 23.
30.0	Proceedings Nat. Elec. Light Ass'n., 1910, p. 336; also Trans. A. S. C. E.—1899, p. 304.
34.0	Proceedings Nat. Elec. Light Ass'n., 1910, p. 336.
27.0	Proc. Pac. Ry. Club, March 18, 1905, p. 276.
14.8	Trans. A. S. C. E., 1885, p. 317.
13.0	Trans. A. S. C. E., 1885, p. 317.
10.0	Trans A. S. C. E., 1899, p. 349.
9.0	Trans. A. S. C. E., 1899, p. 304, also N. E. L A., 1910, p. 336.
21.0	Railway Gazette, 1900, Vol. 32, p. 23.
12-16	Preservation of Timber, by S. M. Rowe, p. 295, 1907 Ed.
15.0	Am. Ry. Eng. and M. of W. Ass'n., Proc., 1907, p. 470.
14-16	Trans. A. S. C. E., 1885, p. 318.
14-16	Trans. A. S. C. E., 1885, p. 318.
12-14	Trans. A. S. C. E., 1899, p. 349.
10.91	Report sent to F. S. by E. E. Calvin, So. Pac., 1912.
20.0	Proc. Am. Ry. Eng. & M. of W. Ass'n., 1912, Vol. 13, p. 872.
10.71	Railway Gazette, 1905, Vol. 38, p. 282.
10.57	Railway Gazette, 1905, Vol. 34, p. 202.
10-15	Trans. A. S. C. E., 1901, p. 503.
15-20	Trans. A. S. C. E., 1901, p. 503.
15.0	Trans. A. S. C. E., 1901, p. 503.
12.0	Trans. A. S. C. E., 1901, p. 503.
25.0	Am. Ry. Eng. & M. of W. Ass'n., Bul. 118—p. 85-93.
25-30	Railway Gazette, 1901, Vol. 33, p. 164.
24.0	Nat. Elec. Light Ass'n., Proc., 1910—p. 336, also Trans. A. S. C. E., 1899, p. 304.
28.0	Nat. Elec. Light Ass'n., Proc., 1910—p. 336.
15.0	Nat. Elec. Light Ass'n., Proc., 1910—p. 336, also Trans. A. S. C. E., 1899, p. 304.
20-25	Trans. A. S. C. E., 1899, p. 349.
8.25	Proc. Wood Preservers' Ass'n., 1911, p. 123.
10.0	Proc. Wood Preservers' Ass'n., 1911, p. 123.
12.0	Trans. A. S. C. E., 1899, p. 304, also N. E. L. A., 1910—p. 336.
8-10	Trans. A. S. C. E., 1901—p. 503.
20.0	Nat. Elec. Light Ass'n., 1910, p. 336, also Trans. A. S. C. E., 1899, p. 304.
23.0	Nat. Elec. Light Ass'n., 1910, p. 336.
20.0	Am. Ry. Eng. & M. of W. Ass'n., Bul. 118, p. 85-93.
13-16	Trans. A. S. C. E., 1885—p. 317.
6.6	Trans. A. S. C. E., 1901, p. 503.
10-15	Trans. A. S. C. E., 1901—p. 503.
9.0	Trans A. S. C. E., 1899—p. 311.
14.0	Proc. Am. RY. Eng. & M. of W. Ass'n., Vol. 13, 1912, p. 872.
8.0	Railway Gazette, 1901, Vol. 33, p. 164.
15.0	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
15.0	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
12-15	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
12.0	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
25-30	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
16-20	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
12.0	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
16.0	Trans. A. S. C. E., 1901, Vol 45, p. 501.
15.0	Trans. A. S. C. E., 1901, Vol. 45, p. 501.
8.84	Railway Gazette, Vol. 38, 1905, p. 282.

mercial product, extremely uniform in its composition and the quality can be readily duplicated and obtained. Creosote, on the other hand, varies considerably in its composition, and is not easily secured in satisfactory grades. The American Railway Engineering Association recently drew up three specifications for creosote to be used in tie preservation, and more discussion and argument has taken place over what kind of an oil should be used than has taken place over any other feature of wood preservation.

It is the author's opinion, however, that these conditions are changing for the better and that the future looks bright.

The Combustibility of the Preservative.

Zinc chloride is non-inflammable; creosote is inflammable; hence a zinc chloride plant presents a lower fire risk than a creosote plant. Zinc chloride-treated ties can be considered more fire resistant than untreated ties. When freshly treated creosoted ties are easily ignited, but their resistance to inflammability increases as their seasoning progresses. Inflammability tests gave a temperature of ignition for zinc-treated wood of 287° C., 19 per cent of the wood, by weight, being burned. Freshly creosoted wood tested under the same conditions ignited at 176° C., and 40 per cent of its weight was burned. When, however, it was air-seasoned after treatment for 90 days the temperature of ignition was 216° C., and the loss in weight 27 per cent.

Ease of Handling the Preservative and Ties Treated With It.

Zinc chloride solutions can be readily handled at much lower temperatures than coar-tar creosote and do not present the many difficulties of heating that accompany the operation of creosote plants; on the other hand, they cause a great plant depreciation, due to their corrosive action. Several cases have come to my attention where trouble was experienced in getting track men to handle creosoted ties, supposedly on account of their disagreeable nature and their effect on the health of the track men. Such objections can, however, be avoided. I have heard of no complaints against zinc-treated ties in this connection.

Inflammabilty of Treated Hemlock.*

How treated	Temperature of ignition °C. Days after treatment.		Loss in weight due to burning calculated in % of of weight before ignition. Days seasoned		Character of combustion
	2	90	2	90	
Untreated	320	———	29	———	Burned freely.
Full cell process	176	216	40	27	Burned freely, black smoke, easily extinguished.
Burnett process	———	287	———	19	Hard to ignite, burned poorly, easily extinguished.

Ease With Which the Preservative can Be Tested and Analyzed in the Tie.

The presence of creosote in the ties can be detected more readily than the presence of zinc chloride; and, inasmuch as a knowledge of the depth of penetration is highly important, creosoted ties are much easier to examine. A chemical analysis of the treated ties is not feasible for daily use, so that the best method of detecting the depth of penetration in zinc-treated ties is to cut a section and apply chemicals to produce color changes, or to heat the freshly-cut section in an oven above the boiling point of water.* However, a careful inspection of the treating plant and process is worth as much, if not more, than a critical examination of a few ties.

Summary of Results.

All the factors discussed above are summarized in Table 4. Its study will show that there are good grounds for hesitating in the selection of a preservative to be used in treating ties, and that the conditions peculiar to each road, or even parts of the same road, should affect such a decision. No sweeping generality can have much practical significance. The more noteworthy points brought out by this study are at present:

(1) Zinc chloride and coal-tar creosote, when used under normal conditions, are both effective preservatives of cross-ties, and there is little choice between them so far as annual charges are concerned.

(2) Creosoted ties in general cost initially more than Burnettized ties, the cost of treatment being from about 2 to 3 times as great.

*Tests to determine the Commercial Value of Wood Preservatives, by Howard F. Weiss, Volume 13, page 279, Eighth International Congress of Applied Chemistry.

*Forest Service Circular 190, by Ernest Bateman, and American Wood Preservers' Association Proceedings, 1912, page 187.

(3) Creosoted ties last, on an average, longer in the track than Burnettized ties, hence require less frequent renewals and changes in the roadbed.

"I might say there is one phase I did not emphasize in this paper, and that is this: It is getting more and more difficult to acquire a satisfactory supply of hard wood for manufacture into cross ties. Therefore, it would appear that companies should handle their ties so that they will secure from them the greatest maximum life, thus necessitating the purchasing of a fewer number of ties. That point is not brought out in this paper. It is an important point from a practical standpoint."

(4) If creosote advances appreciably in price it will very probably result in stimulating the number of ties treated with zinc chloride.

"These are the four general conclusions that I have drawn as a result of this study, and I assure the association that I would be very glad, indeed, to have any additional data that bears on this problem and to have the discussion just as full as you might wish to make it.

Table 4.—Synopsis of the Comparison of Zinc Chloride With Coal-Tar Creosote for Preserving Ties.

Factors Considered	Zinc Chloride.	Coal-tar Creosote.
Toxicity	Toxic limit about .4 per cent.	About same as for zinc chloride
Volatility of Preservative in tie	Nonvolatile	Volatile
Leachability of preservative	Leaches from wood	Does not leach from wood
Penetrance of preservative	Penetrates easier than creosote	More resistant than zinc chloride
Effect on strength of ties	Produces but little weakening	Weakening of no practical importance
Corrosion of metal	More corrosive than creosote	Corrosive action insignificant
Effect as an electrolyte	Favors current leakage	Much more resistant than zinc chloride
Uniformity of composition	Very uniform	Very variable
Cumbustibility of treated wood	More resistant than untreated wood	Much more combustible than zinc-treated wood
Ease of handling	Easier than creosote	More difficult than zinc chloride
Ease of testing penetration	More difficult than creosote	Simple
Financial saving due to use	Slightly less than for creosote	Slightly more than for zinc chloride
Cost of treatment	Lower initial cost than creosote (About 15c. per tie.)	Higher initial cost than zinc chloride (About 30c. per tie)
Ultimate life	Shorter than creosote (About 12 years)	Longer than zinc chloride (About 17 years)

THE PRESIDENT: May we have the pleasure of hearing from Mr. Goltra on this same subject.

Discussion of Mr. Weiss' Paper by Mr. Goltra.

MR. W. F. GOLTRA: This is a well-written paper and deserves very careful reading and consideration. I have very carefully considered Mr. Weiss' paper and desire to make a few remarks.

The successful treating of ties depends on two general factors, namely: (1) Method of seasoning, preparation for service in track and mode of injection of the preservative into the wood; (2) kind and quantity of preservative used. The relative importance of these two factors are in the order named. Many preservatives have been tried and recommended, but only a few have been chosen and the long list has practically narrowed down to the following preservatives:

1. Chloride of Zinc.
2. Coal Tar Oil and Petroleum Tar Oil (Creosote).
3. Crude Oil.

The first two are used in much larger quantities than crude oil. Crude oil has not been used very extensively for treatment of cross ties in this country, but this is not because it is inferior to either of the first two named, but on account of another reason which I will mention later on.

Referring to Mr. Weiss' table No. 1, he gives the number of ties treated with zinc chloride and creosote oil during the years 1907 to 1911 inclusive, but he omits to include such ties as were treated with a combination of zinc chloride and creosote oil; also omits those treated with crude oil; therefore his statement is apt to be a little misleading in comparing the number of ties treated with the various preservatives.

From an examination of the records, I find that during this period the number of ties treated with the mixture of zinc chloride and creosote and crude oil is as follows: 1907, 4,240,000; 1908, 5,515,000; 1909, 4,039,000; 1910; 6,506,000, and 1911, 5,184,000.

As the percentage of the mixture was approximately twenty per cent. creosote oil and eighty per cent. zinc chloride solution, it would seem proper to divide these quantities between these two ingredients on the same basis, after deducting the number of ties treated with crude oil, to arrive at a more nearly correct comparison of the use of these two preservatives. For example, in the year 1911, of the 5,184,000 ties, approximately 1,000,000 were treated with crude oil and the remainder with the mirture, so that twenty per cent. of 4,000,000 or 800,000 should be credited to creosote oil treatment, and the eighty per cent. or 3,200,000 should be credited to zinc chloride treatment. That is the way it looks to me. We should not ignore the treatment of such a large proportion of the ties, because they are treated with a mixture or with crude oil, otherwise we are apt to draw wrong conclusions. But even if these modifications were made to his statement, it would afford but little criterion to go by to determine which is the best wood preservative. The fact that the use of creosote oil in treatment of railroad ties

in this country has increased more rapidly than the use of zinc chloride, is no proof that the former is better than the latter. Mr. Weiss gives nine replies received from operators of wood preserving plants, giving their opinions why the number of ties treated with zinc chloride did not increase. For the most part, these reasons are vague and non-essential. The third quotation which he mentions, that "The salesmen of coal tar creosote are more industrious than the zinc salesmen," comes the nearest the mark of any. (Applause.) The most essential reason for the great increase of creosote oil over zinc chloride is not stated by Mr. Weiss. This reason which I am about to state outweighs tenfold the nine that are specified.

It is a well-known fact that prior to the year 1905, practically all of the crossties treated in this country were treated with chloride of zinc singly or in combination with other ingredients, such as tannin, glue and creosote oil. At that time exploiters of patented creosote processes, otherwise called "empty cell" processes, appeared in the timber-treating industry. They represented that much economy could be effected by treating ties with a partial dose of creosote oil; that by means of an initial air pressure or a final vacuum, or both, the ties could be completely saturated and a large proportion of oil injected into the wood could be recovered. These exponents succeeded in making several railway managements believe it. One large system, The Atchison, Topeka & Santa Fe Railway, that had used zinc chloride treatment successfully for more than twenty years, adopted one of these untried processes, and rebuilt one of their plants at a great expense to employ this new method—the Rueping process. Other roads followed their example, and this process was adopted by the Chicago, Rock Island and Pacific; Missouri, Kansas and Texas, and the Illinois Central Railroad. In all, about 5,000,000 ties are treated annually by this process. In 1904, Mr. C. B. Lowry, of Lexington, Ky., obtained a contract from the Cleveland, Cincinnati, Chicago and St. Louis Railway Company to treat 550,000 ties per annum with creosote oil, for a period of ten years. He organized a commercial company and built a plant at Shirley, Ind., which was subsequently merged into the American Creosoting Company. A couple of years later Mr. Lowry obtained a patent "for withdrawing surplus oil by means of the application of a final vacuum." (*See Foot Note.*) Contracts similar to that made with the Cleveland, Cincinnati, Chicago and St. Louis Railway were as follows:

This process had been practiced in Europe and America for more than 40 years when Mr. Lowry obtained his patent. The operation is employed in nearly every treating plant in this country, at the present time, for the purpose of hastening of the drying of ties before withdrawal from the cylinder. This process is described in Mr. Weiss' paper as "Full Cell Process," but the patentees call it an "Empty Cell Process." (Author.)

Road.	Location.	Year Built.	Treated.
Chg., Indpls. & Lvle. Ry.,	Bloomington, Ind.....	1905	250,000
Rock Island-Frisco Lines,	Kansas City, Mo.....	1907	750,000
Rock Island-Frisco Lines,	Springfield, Mo.....	1907	750,000
Rock Island-Frisco Lines,	Hugo, Okla.....	1907	750,000
Rock Island-Frisco Lines,	Marion, Ills.....	1907	750,000
L. S. & M. S. & M. C. R. R,	Toledo, O.....	1909	1,200,000
Delaware, Lack. & Western,	Patterson, N. J.....	1909	500,000
Lehigh Valley Ry.,	Bound Brook, N. J.....	1909	400,000
Kansas City Southern Railway, International & Gr. Northern, Texas & Pacific Railway,	Shreveport, La.....	1910	750,000
N. Y. C. & H. R. R. R.,	Rome, N. Y.....	1911	750,000
New Orleans Gr. Northern Ry.,	Bogalusa, La.....	1912	200,000

The above, including the C., C. C. & St. L. Ry's contract makes a total of 7,600,000 ties, and is the minimum quantity to be treated annually by the Lowry process, during the life of these contracts.

All of these contracts were for terms of ten or twenty years, and specify that the ties shall be treated by the "Lowry" process, using an average of two and one-half gallons of coal tar creosote oil per tie.

By virtue of the adoption of these so-called "empty-cell" processes by certain railroads, and by virtue of the long term contracts made by other railroads for treatment of their ties by independent treating companies, which in both instances required the use of creosote oil exclusively, such preservatives as zinc chloride, crude oil or other antiseptics having any merit were excluded and were put beyond consideration. There was no choice left in the matter of selecting the most efficient and economical preservative, and in this way competition was stifled.

During the year 1905, I estimate that approximately fifteen million ties were treated, of which about ten per cent., or 1,500,000 ties, were treated with cresote oil and 13,500,000 with zinc chloride. The quantity of ties treated with creosote oil gradually increased until 16,510,000 ties were treated with this preservative in 1911. Of this quantity I estimate that approximately thirteen million were treated by the so-called "empty cell" processes, injecting only a partial dose of creosote oil into the ties. The adoption of these processes by various railroads absolutely precluded the use of anything else but creosote oil; therefore, is it any wonder that there has been such an increase in the number of ties treated with that preservative? Those were the chief causes, and they outweigh all others tenfold, in explaining why the number of ties treated with zinc chloride in this country did not increase more during the past seven years.

The same reason explains why such a comparatively small number of ties were treated with crude oil. If this preservative was offered by dealers to any railroad company or the treating company, treating ties

by these "empty cell" processes, they were usually informed that under their contracts they were restricted to the use of creosote oil, and no matter how meritorious their product might be, it could not be used. Now heavy crude oil or petroleum is a good preservative. It has been used from time immemorial for preserving wood from decay and to protect it from insects. In Burmah there are upwards of 100 pits or wells, with a general depth of 210 to 240 feet, the shafts of which are square forms and lined with horiontal balks or timbers. The oil which is extracted in buckets splashes on the timbers and saturates them with oil. In this way the timbers in these shafts have been protected from decay for centuries. Numerous cases of this character have been seen in this country. There are long stretches of oil soaked track in the oil regions of Pennsylvania that should get the full benefit of its preserving qualities, but no data is available. It appears with the success met with on the Gulf, Colorado & Santa Fe Railroad in using crude oil petrolium for protecting railroad ties from decay that this oil may be of great value in wood preservation. A test was started in 1902, and the ties treated with Bakersfield oil, to the extent of 23 to 82 pounds of oil per tie. Most of these ties are still in good state of preservation. The Atchison, Topeka & Santa Fe Railroad is now operating a treating plant at Albuquerque, New Mexico, using this material, and it is said they are getting good results. Some ties treated with petrolium and laid in the tracks of the Central Railroad of New Jersey, near Bound Brook, New Jersey, remained in the track protected from decay for twenty-six years.

Someone asks, "Why is not heavy crude oil as good as creosote oil for treating railroad ties?" I reply that it is. "But," my friend asks, "must not the preservative be poisonous?" To this I answer, "no, not necessarily." Right here I want to ask our Association to warn men not to subscribe to the doctrine of some chemists touching the hypostatical principal, that a preservative must possess a toxical or poisonous property to be effective, until they have examined it a little. There are substances which prevent decay that are not in the ordinary sense considered poisonous and crude oil or petroleum tar oil are some of them. Much of the development in the line of timber treating has been on the supposition that the wood must be impregnated with a germicide—a substance that tends to destroy animal and vegetable life; but we find substances that are not germicides that do preserve wood and it is presumable that this element is not absolutely essential, although it may play a part in the preservation of wood. It would seem that any antiseptic that would resist or correct putrefaction in the wood, will prevent decay, although it may not be germicidal or of poisonous character, and if wood is rendered unfit by an antiseptic or protected by a germicide or both, it will not decay. An antiseptic may be substances which will inhibit the growth of

fungi, while germicides are understood to be substances which are active poisons to these growths. Thus coal tar creosote is strongly antiseptic and germicidal. Water gas or petroleum tar creosote is antiseptic and probably germicidal. Wood creosote has strong antiseptic properties, while petroleum or heavy crude oil is probably not germicidal, but it is antiseptic.

About the middle of the last century when creosoote oil was beginning to be used to some appreciable extent in Europe, the specifications called for at least ten per cent. of tar acid. which is chiefly carbolic acid and is a virulent poison. At that time it was generally supposed that the acid was the chief element of the preservative, but gradually the oil specifications reduced the requirement until it was eliminated altogether from the specifications Some authorities pointed out that carbolic acid was solvent in water and evaporated quickly and therefore afforded little or no protection to the wood. Whether or not these conclusions were correct I do not pretend to know, but suffice to say that the idea that the preservatives to be efficacious must be of a poisonous or germicidal character underwent considerable change.

Incidently I desire to state that creosote oil distilled from petroleum tar contains no carbolic acid and yet it is a good preservative and used in very large quantities in this country. I do not suppose that many of you know that about one-half of the "creosote" oil manufactured in this country is made from petroleum tar and the other half is made from coal tar. Specifications for "creosote" usually say that the oil shall be obtained from coal tar, but, nevertheless, one-half of it is obtained from petroleum tar. Two-thirds of the gas used for illuminating purposes in the United States at the present time, is water-gas, made from petroleum and about 80,000,000 gallons of tar are made as a by-product of its manufacture. On account of the well-known preservative value of coal tar creosote and its relatively higher cost, oils of other origin are generally looked upon as adulterants, and while the preservative value of the coal tar creosote may not have been lessened by the admixture, the practice constitutes a fraud if the material is sold as straight **coal tar creosote.** In Bulletin No. 78 of the Forest Service the following statement is made:

> "Petroleum tar creosote is already used in large quantities, most of it being sold not under its own name, but as an adulterant of coal tar creosote. It contains some of the most important constituents of coal-tar creosote, as well as those of the paraffin series. Its analysis by fractional distillation is sometimes identical with that of the coal-tar product, and it is probable that after injection into the timber it would show no more rapid volatilization."

Specifications for creosote oil, should be revised and include oil obtained from the distillation of petroleum tar and wood tar as well as from coal tar, and avoid further deception on that score. And finally. if petroleum tar oil is a good preservative, why are not the heavier fractions of crude oil or petroleum good preservatives? The latter

possesses all the chemical elements of the former, which is derived from them.

As Mr. Weiss very correctly observes, a discussion of all factors entering into the question of treating railroad ties finally simmers down to a discussion of cost. In order to make a comparison of the relative economy of treated ties by various methods and with different chemicals it is necessary to determine, at least to one's own satisfaction, these two factors, namely, (1) cost of treated ties laid in the track; (2) average life of the ties. Given these two factors, the first expressed in dollars and cents and the latter in terms of years, the relative economy of the two can easily be calculated.

Mr. Weiss gives a hypothetical case and assumes that ties "properly" treated with zinc chloride will last an average of twelve years and with creosote, seventeen years, and that the cost of treating is fifteen cents and thirty cents, respectively. He also assumes the cost of an untreated tie is forty-five cents and laying in the track fifteen cents in both instances, which, of course, is correct. These factors are assumed for the purpose of reasoning and deducing proof, and Mr. Weiss quotes some statistics of ties in service and leaves the reader to manipulate these figures in any way he sees fit.

I have taken the trouble to critically examine some of the records given in his Table 3, and find a good many of them of doubtful value to predicate the average life of the ties treated with creosote oil and zinc chloride. For example, the record of ties laid by the Union of German Railways was taken from the proceedings of the National Electric Light Association and those proceedings do not give the authority for the table published in their proceedings.

Before attempting to deduce any idea from this table presented by Mr. Weiss, as to the average life of ties, treated with either preservative, one should critically examine the authenticity and also consider the method or process by which the ties were treated. In referring to these alleged records of the Union of German Railways, Mr. Weiss failed to state that the beech ties and pine ties treated with creosote absorbed 66 to 79 pounds of oil per tie. Now Mr. Weiss would lead us to believe that the life of ties treated with creosote oil in this country, for thirty cents, into which only an average of two and one-half gallons, or 22 pounds of creosote oil is injected would be an average of seventeen years. My opinion is that such ties will have an average life of ten years if treated with an average dose of 22 pounds per tie; or twelve years if treated to refusal, say forty pounds per tie. If treated with zinc chloride to refusal, eleven years. It is understood that the ties are seasoned in open air in the usual way and are not protected by tie-plates. I have given this subject of average life of treated ties

; the
zinc
ls of
: the
ır in
year
then
; are
tex-
ıever
:ated
fe is
and
s of
:vice
their
.oval
hich
life

the
we
con-
un-
rage
rted
ears.
rage
ce a
ears,
g as
icu-
than
k is
eech
eans
and
ıdge
esti-
be-
ırs.
the
e in
tion
e of
sur-
, to

posse
from
As
enter
down
the r
differ
own
laid
facto
terms
calcu

Mr
erly"
years
treati
assur
in th
corre
and
in se
way

I
recor
doub
creos
laid
ceedi
ceedi
proce

Be
by M
prese
also
In re
ways
treat
Mr.
creos
avera
oil is
is th
with
treat
chlo
seas
tie-p

much study and I present herewith a chart (CUT) showing the estimated life of treated ties, treated with creosote oil and zinc chloride, either singly or in combination, by different methods of preparation and treatment. The best practical illustration of the progress of decay will be the facts as they occur. The year in which the ties are put in the track is the starting point; the year in which the first tie fails is another step and the rate from then on is the curve of failure; and the year in which the last ties are removed is the culmination. If every tie were exactly alike in texture, density or soundness, all should fail at once, but this is never so. The curves in the diagram illustrate graphically how treated ties would be removed from the track, when their average life is from eight to sixteen years. The tables show the percentages and tie years for each curve. These curves of failure and tables of percentages can be used to determine closely the length of service railroad companies are getting out of the treated ties now in their tracks without waiting many years. By comparing the removal with the number of ties treated in any one year it will show which curve of failure it is following, and give the probable mean life of the tie, which is the essential thing to know.

In making comparisons with European records to determine the probable average life of treated ties treated in this country, we must not overlook the methods employed for treatment. The conditions must be alike in all cases, otherwise the comparison is unfair. Mr. Weiss quotes cases where it is said ties have an average life of as much as thirty-four years and it is currently reported that in France creosote ties have been known to last thirty years. It should be borne in mind that this is not the mean or average life and cannot possibly be, for if one will undertake to trace a line on this chart for ties having an average life of thirty years, he will find that some of the ties would have to last as long as fifty-eight years. We admit that ties treated in Europe, particularly by French railways, have a much longer average life than those treated in America, for the simple reason that the work is done more thoroughly. I figure the average life of oak and beech ties treated in France, with creosote oil, to refusal (that means forty or fifty pounds on an average per tie), adzed and bored and warmed in ovens prior to impregnation, as near as I can judge from available data, to be fifteen years. I take it Mr. Weiss estimates the average life at seventeen years. Perhaps the mean between these two estimates is about correct, namely, sixteen years.

Referring again to Mr. Weiss' table, he gives some data for the French State Railway, published in the Railway Age Gazette in 1901. The ties referred to were samples at the Paris Exposition in 1900 and therefore are not representative of the average life of ties obtained by the French State Railway. We would not be surprised to find on exhibition at the Panama-Pacific Exposition, to

be held in San Francisco in 1915, and to which we have received an invitation, samples of cross ties, treated with zinc chloride, in this country, that have been in service for thirty years or more. It would not be difficult to collect a number of such ties, but that would not prove anything conclusive.

Again, we would not be surprised to find on exhibition samples of timbers from oil wells, which have been preserved from decay by petroleum for more than fifty years.

Returning to Mr. Weiss' hypothetical case and substituting my estimate of life of ties treated with creosote at a cost of thirty cents each, we have,

Cost of creosoted tie laid in track.....	.90	
Average life.....	10 years	
Annual charge.....		.1107
Cost of zinc treated ties laid in track.....	.75	
Average life.....	11 years	
Annual charge.....		.0855
Difference		.0252

Thus the creosoted ties cost 2½ cents per tie per year more than the zinc treated tie. Multiplying this by the average number of years, which in this case is 10½ years, makes a difference of 26½ cents per tie in favor of the zinc treated tie. My estimate of the average life of ties treated with an average quantity of 2½ gallons of oil per tie, with ordinary air seaasoning, and no tie-plate protection, at ten years, is made advisedly. Unfortunately no records are kept by any of the railroads, so far as I know, treating ties with a partial dose of creosote oil, of the performance or life of ties, but from personal observations of renewals and inquiries made of road masters, and section men, I find that the percentages of renewals in most cases followed closely the ten-year curve of failure shown on this chart, which would mean they would have an average life of ten years.

In view of the foregoing, I desire to offer the following conclusions:

(1) Zinc chloride and coal tar, petroleum tar and wood tar creosote, when used under normal conditions, are effective preservatives of cross ties, and the first named is more economical so far as annual charges are concerned.

(2) The average life of ties depend upon their method of preparation and treatment, and the quantity of antiseptic injected into the wood. Ties treated with either preservative will give good service if properly treated.

(3) Heavy crude oil is a good wood preservative and equally as effective as creosote oil or zinc chloride. The cost per gallon

is about one-half that of creosote oil in certain parts of the country.

Finally, my friends, I trust you will not think that I am exploiting or advertising any particular preservative. I sincerely aim to be fair and unprejudiced and my motive in presenting the foregoing facts to this Association is that any preservative proposed shall be carefully and fairly considered to the end that those preservatives shall be used which effect the greatest economy in treating ties and timbers. I thank you. (Applause.)

PART V

History of Wood Preservation

by

W. F. Goltra.

HISTORY OF WOOD PRESERVATION.

By W. F. Goltra.

In order to write a history on wood preservation the historian must necessarily refer to the records left by many writers. The literature dealing with this subject is voluminous and bewildering, and the writer can only attempt to give in this paper a summary of the historical development of the industry and make brief mention of numerous processes and methods that have been tried and recommended for the preservation of wood. Discussion of the efficiency, practicability and merits of individual processes would, obviously, be beyond the limit of this paper. Numerous processes have been employed for the purpose of preventing the decay of wood from dampness, atmospheric action, or the destructive operation of animals and parisitic plants. The principle in nearly all has been the same, namely, the injection into the vessels of the wood of some material which, by combining with the albumen of the woody tissues, prevents the decomposition or gives it a poisonous character. Some processes advocated consisted simply in external appplication of preservatives to the wood. The trials were attended with varying degrees of success, and of the large number advocated (Paulet mentions 174 in all) only a few have survived. Of these processes many of them would, no doubt, prove effective, provided they could be carefully and economically applied, but most of them have not survived, either through cost of material, difficulties in their operation or their inefficiency.

Very little is known of preservative processes adopted in ancient times. Pliny observes that the ancients used garlic boiled in vinegar with considerable success, especially with reference to preserving timber from attacks by worms; he also states that oil of cedar will protect such timber annointed with it from worm and rottenness. Oil of cedar was used by the ancient Egyptians for preserving their mummies. Tar and linseed oil were also recommended.

The idea of preserving wood by the action of oil is, therefore, by no means new, as we find that the ancients used vegetable, animal and mineral oils for the preservation of wood used for various purposes. The petroleum oil wells near Prome, in Burmah, have been used from time immemorial. Wood for shipbuilding and house building was invariably saturated or coated with a product of those wells, and it is stated that the results were entire immunity from decay and the ravages of the white ants. Many other substances have been employed for the preservation of timber, which will be referred to later.

The oldest of all artificial processes for the preservation of timber, and one used among most savage tribes, is charring the surface of wood that is to be inserted in the ground.

Very little is known of any preservative process previous to the year 1657. In that year Johann Glauber, the famous chemist of Carlstadt, Germany, experimented with vegetable pyroligeous acid, the wood having been first carbonized by the action of fire, then covered with a coating of tar and immersed in the acid. (Pyroligneous acid is obtained by the distillation of wood. It is an acetic acid, holding in solution oily impurities.) Since this period many processes have been tried. In order to convey some idea of the numerous experiments the writer presents herewith a list of the different processes proposed for the preservation of wood from the year of 1657 to 1846, prepared by Mr. J. A. Stoeckhardt and published in the "Artizan," London, England, April, 1848:

From this compilation it will be observed that nearly every substance under the sun, from vapor of eupion to a mixture of tar and decoction of tobacco leaves were used for the preservation of wood.

In 1737 Mr. Emmerson patented a process of saturating timber with boiled oil mixed with poisonous substances; but this process was very little used. This, we believe, was the **first** patent on wood preserving.

About 1740 Mr. Reid proposed to arrest decay by means of a certain vegetable acid (probably pyroligneous acid). The method of using it was by simple immersion.

In 1756 Dr. Hales recommended that planks at the water-line of ships should be soaked in linseed oil to prevent the injury to which wood is subjected when alternately exposed to wet and dry; and, indeed, many ships were built in which a hollow place was cut in one end of each beam or stern-post which might constantly be filled with oil. Sometimes the tops of the ship masts were hollowed in the form of cups or basins and holes bored from the end to a considerable way down the masts and oil was poured into these cups and it was left to find its way down the capillary vessels to the interior of the timber.

Before the earliest of these dates, however, the preservative properties of solution of slack-lime and chloride of sodium, or common salts, were facts of common knowledge. The former was extensively used throughout Britain for timber for estate work. Fence timber treated with this solution often lasted upwards of 20 years; the imbibition was by immersion in open tanks.

At the beginning of the Eighteenth Century a member of the Royal Academy of Stockholm called attention to the use of **alum** for preserving wood from fire, stating that wood or timber for the purpose of building may be secured against the action of fire by letting it remain for some time in water wherein vitriol, alum or any other salt has been dissolved which contains no inflammable parts. In 1815 Mr. Wade found that alum was not a good preservative and caused speedy decay of timber. In the same year

No.	Date.	Discoverer.	Preparation Employed.	Mode of Application.
1	1657	Glauber	Vegetable tar and pyroligneous acid.	The wood having been carbonized by the action of fire, is covered with a coating of tar and immersed in pyroligneous acid.
2	1740	?		Exposing the wood to the action of vapor.
3	1798	Volmeister.	Solution of sea water.	Washing and immersion.
4	1806	Perkins.	Ditto.	The interstices of the wood filled with dry salt.
5	1815	Bowden.	Salt water.	Repeated immersion of the wood in the sea.
6	1820	Pasley.	Undecomposable liquids, such, for instance, as the acids.	The wood is first boiled in water, and then the concentrated liquids applied.
7	1821	Knowles & Davy	Chloride of Mercury.	Immersion.
8	1821	Dimsdale.	Vegetable tar, from which the pyroligneous acid had previously been extracted.	Repeated Immersions.
9	1822	Prechtl.	Vapor of tar.	The wood is first exposed to the vapor of water alone, and afterwards to that of a mixture of water and tar.
10	1823	Oxford.	Oil of tar, previously treated with gaseous chlorine.	Repeated coatings.
11	1824	Cox.	Mixture of fish oil, rosin and sulphur.	Saturated by coating the wood and rubbing.
12	1825	Langton.		Extraction by a vacuum of the air from heated wood.
13	1826	Newmarch.	Mixture of linseed oil, sulphate of iron, verdigris, arsenic and alum.	Boiling the wood in the mixture for three hours.
14	1828	Gossier.	Saline solutions, forming mutual decompositions, and leaving in the wood an insoluble combination: for instance, (a) Chloride of calcium; (b) Glauber salts, sulphate of iron, arseniate of soda.	Alternate immersions in solutions of the various salts.

No.	Date.	Discoverer.	Preparation Employed.	Mode of Application.
15	1829	Carey.	Mixture of salt, powdered charcoal, and animal or vegetable oil.	The wood having been perforated at different points, the mixture is introduced and the hole closed.
16	1831	Breant.	Oily and resinous matters, or solutions of appropriate salts.	The wood is impregnated by pressure in a vertical cylinder, in the natural state, or after having exhausted the air and the sap. The exhaustion is performed by means of another large cylinder communicating with the first, and into which the steam passes, which is condensed by an injection of cold water, and which answers the purpose of an air pump.
17	1832	?	Smoke.	The wood is exposed for a long time to the smoke of green wood, burning slowly.
18	1832	Kyan.	Solution of chloride of mercury.	Immersion, and afterwards by pressure.
19	1832	? and since Chevalier, 1836.	Tar and decoction of tobacco leaves.	Immersion or coating.
20	1833	?	Solution of rosin in fish oil.	Coating and repeated rubbing.
21	1833	?	Solution of india rubber in fatty oils.	Idem.
22	1834	Strutzke & Soc. of Arts, Berlin.	Solution of sulphate of iron.	Repeated coatings, or introduction of wood with beds or layers of iron pyrites.
23	1835	Monteith.	Lime water.	Immersion.
24	1835	?	Solution of rosin in oil of turpentine.	Rubbing with a hot solution.
25	1835	Moll.	Vapor of eupion and creosote.	Exposing to the action of the vapor of the eupion and creosote in closed and heated vessels.
26	?	?	Concentrated sulphuric acid.	Coating to carbonize the surface of the wood.
27	1837	Flockton.	Oil of tar and pyrolignite of iron.	Immersion.
28	1837	Granville.	Refuse water of salt works.	Idem.
29	1837	Letellier.	Chloride of mercury and solution of gelatine.	The wood is immersed in a solution of the chlorine, dried, and then coated with a slight layer of glue.

No.	Date.	Discoverer.	Preparation Employed.	Mode of Application.
30	1837	Gotthill.	Resinous solutions; as, for instance, tar and oil of turpentine, with the addition of salt.	Immersion from one to two hours in a solution heated from 275 to 399 deg. Fah., with or without application of pressure or a vacuum.
31	1837	Margary.	Solution of sulphate or acetate of copper	The wood first dried is then immersed in the solution.
32	1837	Industrial Society of Annaberg.	Soluble glass and hydrochloric acd.	The wood is immersed for thirty days in the soluble glass, and then placed in water acidulated with hydrochloric acid, washed, dried, and rubbed with oil.
33	1838	Treffy.	Salts which mutually decompose each other, as, for instance, (a) Chloride of tin or copper, (b) soda or lime water.	Alternate immersion in the liquids.
34	1838	Burnett.	Chloride of zinc.	Immersion of from ten to twenty days.
35	1838	Bethell.	Bituminous liquors, or those which contain creosote; for instance, oil of tar, pyrolignite of iron deprived of ammonia.	Extraction of the air, and introduction of the preparations by means of powerful pressure.
36	1839	Boucherie, and afterwards Uzielli.	Pyrolignite of iron, pyroligneous acid, muriate of lime, sulphate of copper, chloride of mercury, etc.	The solutions are introduced by the natural absorbing power of the living tree, or incorporated with the wood immediately after it is cut down.
37	1840	Feiselli.	Substances which mutually decompose each other, as, for instance, soluble glass, and afterwards dilute sulphuric acid, or solutions, first of alum, and afterwards of potash.	The wood is first steamed in a cylinder, the solution of alum or other salt is then introduced and boiled by steam; the alum fixed in the wood is then decomposed by solution of potash.
38	1840	Munzing.	Sulphate of muriate of protoxide of manganese, the refuse liquor of the chlorine works.	Immersion in the solution.
39	1841	Pons.	Solution of nitrate of iron, saltpetre, alum, and ferocynanide of potassium.	Idem.
40	1841	Payne, and afterwards Banner.	Salts which mutually decompose each other; as, for instance, muriate of lime. sulphate of iron and potash, and alum and potash.	The wood is placed in an iron cylinder, in which a vacuum is produced, and then filled with the first solution, which enters the wood by powerful pressure; this so-

No.	Date.	Discoverer.	Preparation Employed.	Mode of Application.
				lution is then run out and the second introduced, when the pressure is again employed; in some cases it will be found necessary to dry the wood either partially or entirely between the first and second saturations.
41	1842	Timperly.	Chloride of mercury.	Immerson.
42	1843	Parkes, afterwards Passey, 1845.	Caoutchouc dissolved in carburet of sulphur eupion.	Coating or impregnating.
43	1843	Earle.	Solution of sulphate of iron or copper.	Immersion.
44	1844	Burkes, and after Reichenbach.	Soluble glass and sulphate of iron.	The wood is first steamed, then impregnated with solution of sulphate of iron, and lastly with the soluble glass.
45	1845	Ransome, and afterwards Newton.	Solution of silica in caustic soda (soluble glass), afterwards decomposed by an acid.	After having expelled the air from the pores of the wood, the solution of soluble glass is introduced by pressure; afterwards place the wood a short time in a diluted acid.
46	1846	Venzat and Banner.	Solution of sulphate or muriate of copper, afterwards decomposed by baryta.	Impregnation, as No. 40.
47	1846	Payne.	Solutions of metallic sulphurets (lime and barytal), decomposed afterwards by an acid or metallic salt (sulphate of iron, etc).	Extraction of the air by the vapor of water, and alternate introduction by pressure of the preparations which can decompose each other, as No. 40, so as to leave in the wood a deposit of sulphur or metallic sulphuret, insoluble, and of sulphuret of lime.

Mr. Wade recommended the impregnation of timber with resinous or oleaginous substances (preferring linseed oil to whale oil), or with common resin dissolved in a tank of caustic alkali, and that the timber should afterwards be plunged into the water acidulated with any cheap acid or with alum in solution.

In 1811 Mr. Lukin undertook to treat wood by burying it in pulverized charcoal in a heated oven. He erected a large kiln in Woolwick Dockyard, but an explosion took place on the first trial before the process was completed, which proved fatal to eight of the workmen and wounded twelve. The explosion was like the shock of an earthquake. The experiment was not repeated.

In 1815 Mr. Ambrose Boydon, of the English Navy Office, strongly advocated that timber blocks and tree nails of ships should be first boiled in lime water and that they afterwards should be boiled in a thin solution of glue, by means of which the pores of the wood would be filled by a hard substance insoluble in water, which would not only give the timber durability by preventing vegetation, but would increase their strength. Glue, he thought, might be used with lime water, or glue and lime water mixed together.

In 1817 Mr. William Chapman published the results of several experiments he had made on wood with lime, soap and alkaline salts. He recommended the use of a sulphate of copper or blue vitriol.

In 1832 Mr. Oxford took out a patent for an improved method of preventing decay of timber. The process proposed was as follows: "The essential oil of tar was first extracted by distillation and at the same time saturated with chlorine gas. Proportions of oxide of lead, carbonate of lime and carbon of purified coal tar were ground and were mixed with oil and the composition was then applied in thick coatings to the substances intended to be preserved."

Active progress in timber preservation dates from the year 1832. During this year Mr. Kyan patented in England the process of corrosive sublimate, or bichloride of mercury, for preventing decay of timber. Corrosive sublimate has the strongest antiseptic properties among metallic salts, therefore its action is highly preservative, but it has several disadvantages. This process is usually called "Kyanizing," after the name of the inventor. It consists of steeping the wood in a solution of corrosive sublimate, the strength of which is usually one pound of salts to ninety-nine pounds of water. The work is usually performed in open masonry pits, without pressure, because of the corrosive effects of the chloride of mercury on metal. It is a very slow process compared with those in which the wood is impregnated under pressure. The process is still used in a small way for impregnating railroad ties in Southern Germany, and there are a couple of small plants

in our New England States. Kyanizing was introduced in England in 1836, but has gone out of use long ago. The process is suitable for treating timbers on a small scale only. Chloride of mercury corrodes iron and steel, and therefore retorts made of this material are impracticable. Simple immersion being found imperfect as a means of injecting the sublimate, Mr. Kyan made an attempt to improve the efficiency of the solution by forcing it into the wood by pressure process. Wooden closed tanks were substituted for the open ones; forcing pumps were added to the operation. Although Mr. Kyan patented his process in 1832, Sir Humphrey Davey had previously used a weak solution of sublimate, to be used as a wash where rot made its appearance. Mr. Kyan, however, was the first to apply it to any extent.

Five years after Mr. Kyan's invention, namely, in 1837, a Mr. Flockton invented a process for preventing decay by saturating timber with oil of tar and acetate of iron. But little is known of this invention; we believe it was a failure. During the same year Mr. Flockton's process was made known, a Frenchman named Letellier recommended saturating timber in a solution of corrosive sublimate and, when dry, in one of glue. During this year Mr. Margary took out his patent for applying sulphate of copper to wood. His patent, as well as Burnett's, taken out a year later, show that the chemical was intended to be introduced into the wood by soaking, or immersion; but this practice was soon abandoned and injection by pressure substituted.

In 1838 Sir William Burnett, formerly Director General of the Medical Department of the English Navy, made known to the public his new process for treating wood. The invention consists of destroyng the tendencies of certain vegetable and animal substances to decay by submitting them to the action of chloride of zinc. The degree of dilution recommended by Mr. Burnett is one part volume by fifty parts of water. At first the method of impregnation was by immersion in open tanks. In 1847 a powerful cylinder of Burnett's construction, hermetically closed, was laid down adjoining the saw-mills in Woolwich Dockyards. With this it was possible to treat large timbers and to apply a pressure as high as 140 pounds per square inch and extracting the moisture, by means of creating a vacuum, from the pores of the wood, which were afterwards filled with chloride of zinc. This process is usually called "Burnettizing," after the name of the inventor. Chloride of zinc is not considered as strong an antiseptic as chloride of mercury, and even considerably less than sulphate of copper, but it is much cheaper than either of these, and is, in fact, the cheapest of all the preservatives. In general, no reaction takes place between chloride of zinc and iron when spikes are driven into zinc-treated ties, but the drawback in its use is that it is, like chloride of mercury, easy soluble and therefore apt to leach out

of the wood impregnated with it. The substance is, therefore, unsuitable for timber to be used in water, such as piling and dock timbers, but it is an excellent preservative for railroad ties and other timbers where they are not constantly exposed to the action of water. This process is in use on many railroads in Europe and America.

In Germany "Burnettizing" meets with much favor. The Stuttgart Technical Convention of 1887 expressed itself as follows:

> "As the experience of those railroads that have from twenty-five to twenty-six years impregnated their sleepers with chloride of zinc, under pressure, after steaming and abstracting the sap, has been satisfactory, and as the system costs only one-third or less compared with impregnation with creosote or corrosive sublimate, many of the railroads have adopted the chloride of zinc process."

A report of a committee to the American Society of Civil Engineers, June, 1885, recommended Burnettizing as the best method for preserving cross ties.

The wood is usually submitted to live steam in the cylinders before impregnation. Steaming the wood under pressure of 15 to 20 pounds per square inch, as done in Germany, preparatory to injection of the solution, no doubt adds to its durability. Tredgold—no mean authority—considers that boiled or steamed timber shrinks less and stands better than that which is naturally seasoned. Barlow, another good authority, is of the opinion that the seasoning goes on more rapidly after the piece is steamed and stacked in open air.

Modifications of zinc chloride processes have been proposed to correct the principal objection above mentioned. One of them is known as the B. M. Process (Bruning-Marmetschke Process for preserving wood, H. Bruning, Manager, Schopfurth, Germany). The process consists of adding aluminum sulphate to zinc chloride, and it is claimed that zinc chloride salts are made more permanent in the wood.

We now arrive at the modern creosoting process, which was invented by Mr. John Bethell, of England, and patented by him in 1838. Mr. Bethell's patent relates more particularly to the **method** of treatment rather than the kind of preservative employed. This consists of the use of closed vessels that contained the timber, in which first a vacuum was produced, the timber being partially surrounded by the chemicals, and being preferably placed in an upright position; then fully surrounded by the chemical and pressure applied to force it into the wood. Mr. Bethell mentions dead oil of coal tar as one of the preservatives which can be used. Three years prior to this a patent was issued to Franz Moll for a treatment consisting of a preliminary heating in a closed vessel, then the admission of the vapor of the first distillation from coal

tar, followed by soaking in this same distillate, which he called cupion—the object of all of which was to season the wood and prepare it for the next treatment, which was soaking in the second distillate, or, as he called it, "creosote" oil. However, this treatment has never been followed in practice, as it wastes the first distillate; and Bethell's method of treatment using the dead oil, which is the second distillate of coal tar, called by Moll "creosote," supplanted it.

Previous to the time of Mr. Bethell's invention practically all impregnation of wood was accomplished by immersion in open tanks or open boilers, and his method of injecting the material into the wood placed in cylinders, hermetically closed, by pressure, it may be said that he is the inventor of what is commonly known today as the **pneumatic pressure process**—at any rate, one of the first to use this process to any appreciable extent. The pressure method of impregnation is the process now employed generally. Open tanks and open boilers are still used to treat material, but only in small quantities.

It is not our intention to say much about creosote oil. More has been said and written about this one preservative than all of the others put together. Suffice to say that creosote oil, now so extensively used for preserving wood, is obtained from coal tar, petroleum tar and wood tar, which, when submitted to distillation, is found to contain a light oil, a heavy oil (creosote), and pitch. Various quantities of creosote are injected into the wood, ranging from five pounds to twenty-two pounds per cubic foot of timber. In France, Belgium and Holland it is customary to inject into the wood all the oil it will imbibe. In other words, to refusal of the timber to take any more.

Creosoting is far from being a cheap process, and for this reason, perhaps more than others, it was slow in being adopted in this country. From 1885, when treatment of ties was undertaken on an extensive scale by the Atchison, Topeka & Santa Fe Railroad at Los Vegas, New Mexico, until 1905, or twenty years "Burnettizing," or zinc chloride process, was used almost exclusively.

Among the many attempts to preserve woods, those processes discovered by Sir William Burnett and Mr. John Bethell, both Englishmen, have proved the most successful and upon which all of the subsequent methods and improvements in treating timber are founded.

A Frenchman named Breant patented his discovery in 1831. It was adopted to a considerable extent in France. Breant's apparatus consisted of a very ingenious machine, which, acting by pressure, caused liquids to penetrate into a mass of wood of large diameter and of considerable length. He may, therefore, be re-

garded as having solved the problem of penetration in a scientific, though not practical, manner.

In 1839 Mr. Boucherie, a Frenchman, patented his process, which consisted in causing a solution of sulphate of copper to penetrate to the interior of freshly cut woods to preserve them from decay. He occasionally used the chloride of calcium, the pyrolignite of iron, prussiate of iron, prussiate of copper and various other metallic salts. As a general rule, sulphate of copper, commonly known as blue vitriol, was used. In this process the liquid is taken up by the tree, either whilst it is growing in the earth or immediately after it has been cut. Not more than one month should elapse before the timber is operated upon, and the sooner it undergoes the process after being felled the better. This process is still in use in France for treatment of telegraph poles, and the method of impregnation is by hydrostatic pressure. After the trees have been felled the poles are ranged horizontally side by side, the butt ends about one foot higher than the top ends. Iron caps with a pipe connection are fastened to the butt ends of the poles. A wooden tank fifty feet above the ground contains the blue vitriol solution. The solution in the reservoir is conveyed by means of a flexible tube to the cap on the end of the poles and is forced through them from end to end by the hydrostatic pressure. This process or treatment is undoubtedly effective, but is an exceedingly slow method.

Sulphate of copper can also be used in a 1½ to 2 per cent. solution for impregnating by pneumatic pressure; but as in this case the cylinders have to be made of copper, this method is not popular.

Mr. Blythe, of Bordeaux, France, patented a process of preparing wood by the injection of heated solutions of sulphate of copper, heated to nearly boiling point and placed in a lead cylinder, protected by wood. In 1846 80,000 ties treated by this process were laid down in French railways and found to give good service. Mr. Blythe also invented another process called thermo-carbolization. This process consisted in treating wood with carburetted steam to extract the saps and water and at the same time inject it with creosote held in suspension. This being a slow and expensive method it has not met with favor.

In 1841 Mr. Payne patented his inventon. The materials employed in Mr. Payne's process are sulphate of iron and sulphate of lime both held in solution with water. The timber is placed in a cylinder in which a vacuum is created; a solution of iron is then admitted into the vessel, the fluid being readily absorbed by the assistance of the vacuum. The sulphate of iron is then withdrawn and another solution of sulphate of lime is run into the cylinder, which enters the substance of the wood in the same manner as the former solution, and these solutions react upon each

other and form new combinations—muriate of iron and muriate of lime. One of the most valuable properties of timbers thus prepared is the perfect incombustibility. When it is exposed to the action of flame or strong heat it simply flounders and emits no flame. The greatest drawback consists in the increased difficulty of working the timber.

Many other processes were suggested by European wood preservers, but it will be sufficient to mention one more, that of Julius Rutger's Zinc-Creosote Process, patented in Germany in 1874. The process consists of four operations: (1) steaming the timber; (2) producing a vacuum and admitting the preservative fluid; (3) the application of the pressure pump, and (4) application of final vacuum to hasten drying of the material. The preservative is a mixture of creosote oil and zinc chloride. A modification of this process has been employed at several plants in the United States and is known as the Card process.

Mr. Samuel B. Boulton, of London, England, obtained a patent in 1879, for process of treating wood. He gets rid of the moisture in the timber simultaneously with the injection of creosote. The wood, either fresh or seasoned, being placed in the cylinder, creosote heated to over 212 degrees Fahr. (the boiling point of water), is admitted, and the air pump is used to exhaust any or all of the water thereby converted into steam, the theory being that the water is simultaneously replaced by warm creosote, which, of course, penetrates the wood more easily than would be the case at a lower temperature, the force pumps being also used if necessary.

While numerous experiments were going on in England, France and Germany to discover the best methods of treating woods, Americans were not idle. The most noted men in the development of the industry in this country are Mr. Octave Chanute, who designed and built several of the early plants and was interested in their operation for nearly twenty years; Mr. Samuel Rowe, who designed the pioneer treating plant at Los Vegas, New Mexico, and who wrote the first American book on Timber Preservation worthy of mention; Mr. A. A. Robinson, who was Chief Engineer of the Santa Fe in 1885, after four years of experimental work, had works built in New Mexico; Mr. Julius Kruttschnitt, of the Southern Pacific, who built works at Houston, Texas, in 1891, and Mr. H. U. Mudge, now President of the Chicago, Rock Island & Pacific Railway, a notable student of wood preservation and one who has done much towards its development and improvement. Among the array of American inventors and practitioners, we make special mention of Seeley, Hayford, Hasselmann, Wellhouse, Isaacs, Curtis and Card. Mr. Seeley was granted a patent in 1867 on a method of impregnating, consisting of immersing the timber in an iron tank filled with oil, heating it to drive out the moisture,

replacing the hot oil suddenly with cold oil, whereby it is forced into the wood by condensation. A patent to Hayford in 1872 added to the use of steam for seasoning, the pressure of hot air to prevent the checking of the timber by more rapid seasoning of the exterior portions of the wood. This method was advocated and followed by E. R. Andrews in his works at Boston. A patent to Messrs. W. G. Curtis and J. B. Isaacs, of the Southern Pacific Railroad, was granted in 1895, covering a process identical with Mr. S. B. Boulton's, except that they did not use the vacuum during the boiling. The philosophy of both is that water is vaporized at 212 degrees, while the oil does not vaporize under 365 degrees. A temperature maintained between these two will drive off the moisture of the water, which can be replaced by oil with pressure. Both of these methods have been used in this country with success.

There is one other treatment which was suggested some years ago and which has some very desirable theoretical features about it, namely, the Hasselmann process. This consists in boiling the timber in a solution of several substances, the principal one being sulphate of iron. There have been a number of treatments proposed whose value was based upon the securing of a chemical reaction in the wood itself, but there has been a good deal of skepticism about the securing of such reactions, and the Hasselmann process seems to be the only one in which clear evidence has been given of success in that regard.

The principal objection to the use of zinc chloride, sulphate of copper and other mineral salts is that such salts are more or less soluble in water. They are effective germicides and as long as they remain in the wood in sufficient quantity will prevent decay. The solutions containing metallic salts are more readily injected than oils, consequently it has been attempted to use them in conjunction, and various methods have been patented for this purpose. Mr. J. P. Card (father of an esteemed member of this Association bearing the same name), proposed a method of first injecting a small amount of tar oil, then immediately thereafter injecting a solution of zinc chloride. He claimed that by this means he secured a much better distribution of the oil in the wood than was possible with the ordinary injection of the same amount of oil and at the same time thoroughly protecting the interior of the stick with zinc chloride. Mr. Card introduced the Wellhouse process on the Atchison, Topeka & Santa Fe at Los Vegas, New Mexico, works built in 1885. This process consisted of the injection of zinc chloride, followed by injections of solutions of glue and tannin, the object of the two latter being to plug up the ducts of the timber by the artificial leather formed by the glue and tannin. This treatment has been in use in this country for a number of years with very satisfactory results.

Another treatment used considerably in this country, is the zinc-creosote, or Allardyce, process, which consists of an injection of a 2 per cent. solution of zinc chloride into the wood, followed immediately by an injection of about three pounds of creosote oil per cubic foot. A number of ties treated this way by the International Creosoting and Construction Company, at Beaumont, Texas, were laid in the track in the year 1900, and a large percentage of them are still in the service at this date.

A second process of zinc-creosote, known as the Card process, was introduced in America a few years ago. It differs in the Allardyce in the fact that an emulsion of zinc chloride and creosote is made and forced into the wood in one operation.

Mention might be made of several other men and processes connected with the timber treating industry in this country, but suffice to say that America has been alert and active in the development of this important industry.

Such are the principal patents, suggestions and inventors up to the close of the last century. Since the beginning of the present century there have been several more processes brought before the public, particularly by Americans, but space does not permit mention of them at this time.

Preservatives.

Numerous ingredients have been proposed for the preservation of timber from decay. In this paper we can only give a recapitulation of the chief ones which have been tried, and some recommended, to prevent the decomposition of timber and the growth of fungi:

Acids: Sulphuric, Tar, Vitriolic.
Carbonates of Barytes, Potash and Soda.
Chlorides of Mercury, Sodium and Zinc.
Sulphates of Alumina, Barytes, Copper, Iron, Lime, Magnesia, Soda, Zinc.
Muriate of Soda.
Nitrate of Potash.
Fish, Whale and other animal oils.
Linseed, Cedar and other vegetable oils.
Petroleum and Crude Oils and other mineral oils.
Oils from distillation of tar obtained from coal, petroleum and wood (creosote).
Molasses and Low Syrups.
Wax, Glue.
Resins and Gums of different kinds.
Quick Lime or Hydrate of Lime.

The preservatives which found most favor and used widely both in America and Europe are, (1) chloride of zinc, (2) creosote oil, and (3) petroleum, or crude oil. Mixtures of various ingredients were also used. They were about as numerous as patent medicines, and some of them about as worthless. The most popular mixture of all is creosote oil and chloride of zinc, and, in our opinion, this combination possesses many merits.

Methods of Impregnation.

The methods of impregnation vary almost as greatly as the preservatives employed in them, but may be classified into two main groups, namely, (1) impregnation by immersion, (2) impregnation by pneumatic pressure.

Immersion is the oldest of methods, long since practiced with milk of lime and brine solution, and was adopted in Kyanizing with a solution of chloride of mercury, and also with other salts. This is the simplest of all methods. Converted woods, such as ties, fence posts, plank or timbers of any kind, are merely steeped and weighed down in liquid contained in a large trough or vat made of wood or iron. The timber must be well seasoned. The solution will not penetrate damp or green wood. Soft woods, about the size of ties or fence posts, need be steeped for a period of eight or ten days, while hardwoods require twelve to fourteen days when immersed in cold solutions. This method is no longer employed on a large scale, but it can be conveniently used for treating fence posts or other material in a small way. The treatment by open tank methods can be expedited by placing the wood in an open tank or open boiler filled with the preservative substance and a fire kindled underneath. The boiling dissolves and extracts the saps and juices from the wood and the preservative is absorbed by capillary attraction. Of course the tank or boiler must be made of iron or steel if a fire is kindled underneath, and in selecting the preservative it must be such as will not corrode the metal. Sulphate of copper or chloride of mercury cannot be used in metal tanks, but zinc chloride, creosote oil, petroleum or crude oil are practicable.

Pneumatic pressure, by means of force pumps, was originally applied by Breant and Payne, and was the method adopted with chloride of zinc by Burnett, and with creosote oil by Bethell; but these older methods have since been improved upon by Blythe, Boulton and others. The pressure process is adapted to the use of chloride of zinc, creosote oil, crude petroleum oils, or any mixture of these substances. This method of impregnation is so well understood that it is unnecessary to describe it in this paper. Suffice to say that the timber is placed in the cylinders six to nine feet in diameter, one hundred to one hundred and forty feet long. A door hermetically closes the cylinder into which the fluid is introduced. Pressure is applied to the fluids in the cylinder, and ranges from a few pounds to two hundred pounds per square inch, as desired by the operator. The wood must be thoroughly dry at the time of injection, otherwise the moisture or vapor will resist the entrance of the preservative. Incidentally, the writer desires to emphasize the necessity of thorough seasoning or drying of timber before the injection of the preservative. It is by far the most important factor influencing the quality of the work. It

is more important than the kind of preservative used and more important than the method of impregnation adopted, for if the timber is not dry the preservative cannot be forced into it, no matter what method of impregnation is employed. The preservative should be forced into the wood until it refuses to absorb any more in order to secure as thorough impregnation and dissemination of the preservative in the wood as possible.

Thorough seasoning can only be accomplished by artificial means. Various methods have been tried and recommended. The French Eastern Railway of France have used the drying ovens or kilns to complete the seasoning of their ties. That road, which is distinguished for doing the best work of any in Europe, commenced to use the kilns to dry wooden ties, which were afterwards impregnated with creosote oil in closed cylinders by vacuum and pressure process (Bethell Process), in 1865. In 1874 they built a new treating plant at Amagne, France. Instead of constructing hot-air dry kilns with direct acting furnaces, they employed dryers with hot-air heaters, giving a more methodical heating. The ties are first air-seasoned for several months and then placed in ovens. The artificial seasoning simply completes air-seasoning and permits the plant to operate at all seasons of the year, besides insures thorough impregnation of the wood. This mode of drying ties has given entire satisfaction, and with the precaution taken in drying, the ties are not deformed. Some ties show small checks and splits, which close up after creosoting. This method is employed by several French companies that treat their ties either by the Burnett or Bethell processes. The Western Railway of France notaby have built a plant at Surder, France, simliar to that built by the French Eastern Railway at Amagne. Undoubtedly kiln drying of ties and timbers before impregnation is the only proper method of putting the material in good condition and securing thorough and uniform seasoning.

Development of the Industry in the United States.

Before the advent of railways the treatment of wood in Europe was primarily for use in construction of merchant and war ships, which were constructed almost entirely of wood, and in America for locks and canals. Small quantities of treated timber were used for structural and other purposes. The invention of the steam locomotive and railway gave rise to the necessity for protecting the wooden ties, or sleepers as they call them in Europe, from decay. From this period may be reckoned the active progress in wood preservation. The treating of railway ties with a preservative of some kind increased rapidly, and very soon the quantity of wood treated in the form of railway ties exceeded that used for all other purposes. This ratio is constantly increasing, and at the present time perhaps 90 per cent. of the wood treated in the United

States consists of railway ties; the remaining 10 per cent. consists of piling, paving blocks, dimension timbers, etc.

Inasmuch as the real active progress in the development of timber preservation did not occur until the advent of railways, and the development of the latter in America was contemporaneous with that of European countries, it may be said that the development of the wood preserving industry was contemporaneous in all countries. A good many experiments were made in America, based largely, however, upon European experience, from which much data was obtained.

The first recorded use of treated ties were some chestnut ties treated with chloride of mercury (Kyan's process) and laid on the Northern Central of Maryland in 1838. Some oak ties treated by the same process were laid in track of Chesapeake and Ohio Railroad in 1840. Presumably both of these were trial lots to determine the value of the process. It is recorded that these ties gave a service of twelve to fifteen years.

The first treating plant worthy of name was probably that at Lowell, Mass., built in the year of 1848 by the proprietors of the locks and canals at that point. The plant consisted of two wooden tanks, each fifty feet long, eight feet wide and four feet deep, in which the timber was immersed in accordance with the Kyanizing process, using chloride of mercury. Chloride of zinc was also used in treating wood at this plant. It was here used for bridge work in connection with canals and not with railroads. This plant is still in use and is now owned by Otis Allen & Son, of Lowell, Massachusetts.

The growth of the treating industy in the United States was slow during the following three or four decades, only a few small plants being constructed. In 1856 the Vermont Central erected Burnettizing works and treated ties for a few years, when the plant was abandoned before any results favorable or otherwise were apparent. Their reason for this was that the delays consequent upon waiting for treated timbers were too great to admit of a continuance and they lost faith in the scheme, only to find that twenty-five years later that they even then had hemlock ties in a side track which had been part of these treated at this plant, and were still nearly sound in spite of their long service.

In 1860 the Chicago, Rock Island & Pacific Railroad built a "Howe" truss bridge 1200 feet long, the timbers in which were Burnettized, and in 1882 these were reported as being still in use and in fair condition.

In 1861 the Erie Railroad built a plant at Oswego, N. Y., confining the treatment to bridge timber and planking. It was burnt down in 1869 and not rebuilt, as the results from the treatment were not considered satisfactory. Subsequent inquiry by a committee developed the fact that the treatment was not well

or carefully done, and the Superintendent of the works afterwards admitted that the material was "hurried through" the process and poor treating done, the General Superintendent of the railroad stating that the "timber was treated in the winter, was full of frost and that the zinc chloride had no effect." No further comment is necessary, as inferior work in the treating plant today will produce simliar results.

The Philadelphia, Washington & Baltimore Railroad and the Philadelphia & Reading Railroad each built works to treat material with zinc chloride and started to treat their ties, the former in 1863 and the latter in 1867. They found that ties would last against decay, but "were brittle as a carrot," caused, of course, by the solution used being too strong, so that the ties were overtreated and had to be removed. However, they were used as fence-posts, and it is said they lasted a long time. It is not definitely known what solution the P., W. & B. R. R. used, but that of the P. & R. R. R. is said to have been 3¾ per cent. strong.

In 1866 the Chicago, Rock Island & Pacific Railway laid 2,000 pine, tamarack and cedar ties in their main track just west of Englewood, Ill. These ties were treated with zinc chloride. In 1882, after sixteen years' service under heavy traffic, 75 per cent. of the hemlock were still in the track and good for two or three years longer, while the pine and cedar came out in fifteen years. The natural life of the untreated hemlock ties in that locality, and under similar conditions for traffic and ballast, was said to be five years.

A number of Burnettized or zinc-clhoride treated ties, consisting of maple, beech and hemlock, were laid in the main line of the Lehigh & Susquehanna Railway in 1867. In 1883 the greater number were still in the track and reported good for seven or eight years longer service.

The Louisville & Nashville Railroad built a treating plant at West Pascagoula, La., in 1875-6. The plant was arranged to treat material by the pressure process with creosote oil. It was built primarily to treat piles, stringer caps and ties used in construction of trestles and docks. Creosote timbers was extensively used in the New Orleans, Mobile and Texas Railroad, extending from Mobile, Ala., to New Orleans, La. Many important structures having been built of creosote timber from 1876 to 1879. The L. & N. R. R. acquired control of the road from Mobile to New Orleans in 1880. In 1882 large quantities of creosote piles, stringers and caps were used in construction of trestles and docks of the Louisville & Nashville Lines in the city of Pensacola, Florida and vicinity. The earlier use of creosote piles was more for the purpose of protecting them from attacks of sea worms or toredo navalis.

However, in more recent years large quantities of creosoted piles and sawed timber have been used by the Louisville & Nash-

ville Lines when not subject to attack of sea worms and have been used mostly for economical reasons.

About 600 long leaf yellow pine ties, which were creosoted at this plant and placed in the track in 1877-1878, remained in the track until June, 1905. The amount of oil injected into these ties is not known, but it is estimated at 15 to 18 pounds per cubic foot or 45 to 55 pounds per tie.

In 1879 the New Orleans and North Eastern Railroad built a pressure plant to treat with creosote oil, at Slidell, La. It was originally built for the purpose of creosoting the timber used in building a trestle across Lake Ponchartrain. After this work was done the plant was closed and stood idle until it was sold to the Southern Creosoting Company, in the latter part of 1902.

The Houston & Texas Central Railroad also built a treating plant at Houston Texas in 1876 to treat piling and timbers generally with creosote oil.

It is not to be supposed that every experiment made in this new field was a success. They were frequently dependent upon men without much prior experience in this line, and who, to some extent, were feeling their way. Neither was it known that, where zinc chloride was used successfully in the case of bridge timber, that it could also be satisfactory with crossties. It seemed to have been tried in some cases where there was necessity of economy irrespective of other considerations, and failure was not, therefore, a cause for surprise. In the majority of the earlier trials, however, the results were favorable, so that about 1878 several other railways made tests with treated cross ties with such success that in 1885 the Atchison, Topeka & Santa Fe Railroad erected a treating plant at Los Vegas, New Mexico, and because of continuous operation of the same to 1906 may be considered the pioneer company in its line. It is true this plant was built eleven years later than the L. & N. R. R. plant at Pascagoula, but it should be borne in mind that this plant was not built primarily for the treatment of railroad ties, as is the case with the Los Vegas plant. The latter plant had two cylinders, and for some years all the ties and timbers treated was by the zinc-tannin process, otherwise known as the Wellhouse. In part of 1890 and all of 1891 and part of 1892 zinc chloride alone was used as a preservative, and from 1900 to date of dismantling of the plant that treatment alone was used.

In 1886 the Chicago, Rock Island & Pacific Railroad, which had previously tried the Burnettizing process with success, made a contract with Card & Chanute (later the Chicago Tie Preserving Company) to treat a specific number of hemlock and tamarack ties each year by the Wellhouse process. So satisfied were they with the results that as each contract expired it was renewed from time to time with an increased quantity. Mr. Octave Chanute figured

up the average life of these ties treated at the Chicago works by three different methods and found it to be 10 2-3 years.

In 1887 the Southern Pacific (Atlantic System) began treating Texas soft pine ties at a leased plant, and in 1891 built one of their own at Houston, Texas. To this company's officials belongs the credit of being the only road having complete record of service given by treated ties from the start. Only the Burnettizing method has been used on that system. So satisfactory were the results that the Pacific System of the same company erected a portable plant in Oregon in 1894 and since then have treated practically all of the ties used on that part of the system.

The heavy increase in cost of ties of durable quality caused several of the Western roads to begin the use of certain woods, the life of which they knew to be very short, but which could be materially lengthened by treatment. Many plants were therefore constructed, either owned by the railroads themselves or by private concerns who treat under contract.

The Atchison, Topeka & Santa Fe in 1897 made a contract with the Texas Tie & Lumber Company, of the Santa Fe, to build a plant at Somerville, Texas, for treatment of their ties with zinc chloride. A second treating plant was also built by the Santa Fe at Bellemont, Arizona, in the same year.

In 1899 the Chicago, Burlington & Quincy built a plant at Sheridan, Wyoming, for treating lodge-pole pine ties from Wyoming and the Black Hills. The Great Northern Railway built a plant at Kalispell, Montana, in 1901, for treating Montana pine, tamaracks, etc. The Missouri, Kansas & Texas Railroad built one at Greenville, Texas, in 1901, and the Mexican Central Railway one at Aguas Calientas, Mexico, about the same time.

At the end of the year 1903 there were twenty-seven timber-treating plants in the United States as shown on the accompanying list.

Railroad ties constituted fully ninety per cent. of the total quantity of material treated during that period, and fully ninety-five per cent. of the ties were treated with Chloride of Zinc, and the remaining five per cent. with Creosote Oil. Some of these plants have since been dismantled or moved elsewhere, such as the Los Vegas plant and the Bellmont, Ariz., plant, of the A. T. & S. F. and the three portable plants of the Southern and Union Pacific Railways.

Growth of the Industry in Europe and America.

The statistics of European Railways relating to number of ties treated from the beginning are meagre and difficult to obtain, and the author can only give an approximation, as can be found in the voluminous and scattered records in various languages, and does not pretend that it is accurate, but may be of some interest to the reader in comparing the figures with those given later for the United States.

Timber Treating Plants in the United States, Dec. 31, 1903.

No.	Location.	Year built.	Name of Company.	Preservative.	Kind of wood.	Number of Retorts	Estm't. capacity per an. ties
			Open Tank Process.				
1	Lowell, Mass.	1848	Locks & Canal Co.	Chl. of Mercury.	Various	2	30,000
2	Portsmouth, N. H.	1875	Otis Allen & Son.	Chl. of Mercury.	Various	4	40,000
			PNEUMATIC PRESSURE PROCESS				
1	W. Pascagoula, La.	1875	Lville. & Nash. Ry.	Creosote.	Pine	2	400,000
2	Long Island City, N. Y.	1878	Eppinger & Russell.	Creosote.	Pine	4	800,000
3	Slidell, La.	1879	Queen & Cres. Ry.	Creosote.	Pine	1	300,000
4	Portsmouth, Va.	1881	Wyckoff Pipe Creosoting Co.	Creosote.	Pine	1	100,000
5	Seattle, Wash.	1884	Colman Creo. Co.	Creosote.	Pine	2	200,000
6	Los Vegas, N. Mex.	1885	A., T. & S. F. Ry.	Zinc-tannin.	Pine	3	500,000
7	Chicago, Ills.	1886	Chgo. Tie Pres. Co.	Zinc-tannin.	Hemlock	4	500,000
8	New Orleans, La.	1888	N. O. Wood Pres. Co	Creosote.	Pine	1	300,000
9	Oakland, Cal.	1889	Sou. Pac. Rv.	Zinc-chloride.	Pine	5	1,500,000
10	Perth Amboy, N. J.	1890	U.S. Wood Pres. Co.	Creo.-Resin.	Pine	4	1,200,000
11	Houston, Tex.	1891	Sou. Pacific Ry.	Zinc-chloride.	Pine	5	1,500,000
12	Cal. & Ore. (Portable).	1894	Sou. Pacific Ry.	Zinc-chloride.	Pine Fir	2	1,000,000
13	Norfolk, Va.	1896	Nor. Creo. Co.	Creosote.	Pine	4	900,000
14	Somerville, Tex.	1897	Texas Tie & Lbr. Co	Zinc-chloride-Creosote.	Pine	6	2,000,000
15	Beaumont, Tex.	1897	Int. Creo. & Con. Co	Zinc-chloride-Creosote.	Pine	1	500,000
16	Bellmont, Ariz.	1898	A., T. & S. F. Ry.	Zinc-tannin.	Pine	2	350,000
17	Mt. Vernon, Ills.	1899	Chgo. Tie Pres. Co.	Zinc-tannin.	Oaks	1	200,000
18	Sheridan, Wyo.	1899	C., B. & Q. Ry.	Zinc-chloride.	Pine	2	500,000
19	Greenville, Tex.	1901	M., K. & T. Ry.	Zinc-tannin.	Pine Gum	3	900,000
20	Kalispell, Mont.	1901	Great Nor. Ry.	Zinc-tannin.	Pine Fir	4	1,200,000
21	Texarkana, Ark.	1902	Int. Creo. & Con. Co	Zinc-chloride	Pine	2	1,000,000
22	Alamogordo, N. Mex.	1902	Alamogordo Lum. Co	Zinc-tannin.	Pine	2	600,000
23	California (Portable).	1902	Union Pacific Ry.	Zinc-tannin.	Pine	2	600,000
24	Oregon (Portable).	1902	Oregon Short Line.	Zinc-tannin.	Pine Fir	2	600,000
25	New Orleans, La.	1902	Amer. Creo. Wks.	Creosote.	Pine	2	400,000
26	Carbondale, Ills.	1903	Ayer & Lord Tie Co.	Creo. Zinc-Chl.	Oaks	6	2,500,000
27	Grenada, Miss.	1903	Ayer & Lord Tie Co.	Creo. Zinc-Chl.	Pine	2	800,000
					Total....		21,350,000

The Railway mileage of Europe, January 1st, 1909, is reported as 195,521 miles. Of this mileage Germany stood first (34,743), followed in their order by Russia (32,743), France (28,430), Austria-Hungary (24,261), United Kingdom (22,847), Italy (10,070), Spain (9,190), Sweden (7,677), Norway (2,931). European railways used a large number of metal ties and space their ties much farther apart than practiced in the United States, so that there are not so many wooden ties used per mile for maintenance in Europe as in the United States.

The number of wooden ties treated annually in Europe is about as follows: Germany, 4,000,000; Russia, 2,600,000; France, 3,000,000; Austria-Hungary, 2,500,000; United Kingdom, 2,300,000; Italy, 1,000,000; all other countries in Europe, 1,200,000; total, 16,600,000 ties. Thus the total quantity of ties treated annually in Europe is about one-half of the number treated in the United States during past year or two.

The total number of timber-treating plants in Europe is between 65 and 70. Approximately 85 per cent. of all wooden ties in use in Europe are treated.

In the United States the data is more copious and reliable. The author has compiled the accompanying statement from various government reports and publications. The steam railway mileage was obtained from Interstate Commerce reports, the electric and street railway mileage from the Electric Railway Journal of New York, for years 1900 to 1912, inclusive; previous to 1900 figures estimated by the author.

The number of ties used by steam and electric railways was obtained from Forest Service Reports from year 1907 to 1911; previous to 1907 from U. S. Census reports and estimated by the author. The number of ties treated from 1907 to 1911, inclusive, from Forest Service reports, previous to 1907 from various publications and estimated by the author. All figures for 1912 are estimated.

The proportion which treated ties formed of the entire number purchased is calculated and given for each year, also number of plants in operation from 1860 to 1912, inclusive, is stated.

Up to January 1st, 1900, approximately 15,000,000 ties were treated in the United States, of which about 14,500,000 were treated with chloride of zinc and 500,000 with creosote oil.

During the year 1903 the number of ties treated was 9,010,000, of which 8,400,000 were treated with chloride of zinc and 610,000 with creosote oil, and during the year 1905 approximately 14,890,000 ties were treated, of which 13,420,000 were treated with chloride of zinc, and 1,470,000 or about 10 per cent. with creosote oil.

During 1907 and 1909 the largest number of plants were built in the United States, being 12 in the former and 11 in the latter year.

The proportion which treated ties form to the entire number

used has gradually increased from one per cent. in 1886 to 24 per cent. in 1912, and we see no reason why these percentages should not increase from year to year until the bulk of them receive a preservative treatment.

Our supply of timber is fast diminishing. We are consuming it at such a reckless rate that some of us may live to see a day of repentance. Aside from the great economy effected by the use of treated ties and timber, there should be in all of us the spirit of pariotism, which will urge us tó husband the resources of our magnificent inheritance of Forests.

Table Showing Miles of Steam and Electric Railways, Number of Ties Used, Number Treated and Number of Plants in Operation from 1860 to 1912, Inclusive.

Year	Miles of Railroads in U. S.	Miles of Street and Electric Railroads in U. S.	Number of ties used by Steam & Electric Railroads	Number of ties treated	Percentage	Number of plants in operation
1860.....	30,626			From 1860 to		
1870.....	52,922			1885, excl.,		
1880.....	93,267			appx. 50,000		3
1885.....	123,320	3,000	50,000,000	120,000	.25	5
1886.....	125,185	3,120	51,000,000	590,000	1.00	5
1887.....	137,028	3,680	56,000,000	504,000	1.00	5
1888.....	145,387	4,112	60,000,000	644,000	1.00	6
1889.....	153,725	4,930	63,000,000	615,000	1.00	7
1890.....	166,703	5,241	68,000,000	600,000	1.00	8
1891.....	168,403	6,155	70,000,000	697,000	1.00	8
1892.....	174,784	7,040	72,000,000	790,000	1.00	9
1893.....	175,980	8,870	73,000,000	812,000	1.1	10
1894.....	178,412	8,949	75,000,000	920,000	1.2	11
1895.....	181,717	10,810	76,000,000	1,289,000	1.7	12
1896.....	183,111	12,133	78,000,000	1,307,000	1.5	13
1897.....	184,428	13,765	79,000,000	1,312,000	1.6	13
1898.....	186,396	15,942	80,000,000	1,826,000	2.3	13
1899.....	189,294	17,665	81,000,000	2,510,000	3.0	15
1900.....	194,262	19,314	85,000,000	2,800,000	3.2	15
1901.....	197,237	22,217	88,000,000	4,101,000	4.6	17
1902.....	202,471	25,592	90,000,000	6,180,000	6.8	22
1903.....	207,977	27,754	94,000,000	9,010,000	9.5	27
1904.....	212,394	29,548	96,000,000	12,800,000	13.3	30
1905.....	217,341	32,517	100,000,000	14,890,000	14.9	34
1906.....	222,635	36,212	102,834,000	16,880,000	16.4	39
1907.....	227,670	38,812	153,703,000	19,856,000	12.9	51
1908.....	231,333	40,247	112,466,000	23,776,000	21.1	57
1909.....	234,799	40,490	123,751,000	22,033,000	17.8	68
1910.....	238,609	40,088	148,231,000	30,544,000	20.6	75
1911.....	242,885	41,028	135,053,000	31,141,000	23.0	81
1912.....	244,000	42,000	140,000,000	33,600,000	24.0	84

PART VI

Timber-Treating Plants in North America
with
Map Showing Forest Regions
and
Location of Plants

TIMBER-TREATING PLANTS IN NORTH AMERICA DECEMBER 31st, 1912.

Compiled from Reports Made by the Various Managing Companies to the American Wood Preservers' Association.

By W. F. Goltra.

The necessity for a complete and authentic list of wood-preserving plants in the United States, Canada and Mexico and collateral information has long been felt by those interested in this industry.

Such lists as have been published heretofore possess meager information regarding the character, capacity and equipment of the plants, processes employed, kinds of woods and material treated, preservatives used and other useful information regarding the timber-treating industry. Until now it has been extremely difficult to gather sufficient information to enable one to compile such a report, but our Secretary, Mr. Angier, has secured complete data and the writer has undertaken to compile it to the best of his ability.

There are two general methods of impregnation, namely:

(1) Impregnation by immersion in open tanks or boilers, also in closed tanks or boilers without pressure. This is commonly known as the Open Tank or Non-Pressure Process.

(2) Impregnation by pneumatic pressure by means of force pumps and air-tight cylinders. This is commonly known as the Pressure Process.

The first method is the simplest and oldest form for applying a preservative. As its name indicates, it consists in dipping or steeping the wood in open tanks, filled with the preservative used. In some cases the wood is boiled in the preservative. Again, in some cases, the wood is placed in a closed cylinder and boiled, but no pressure is applied. It necessarily follows that this is an *absorption* rather than an injection of the preserving fluid. It also follows that the depth of penetration obtained is very shallow, except for particularly open or porous woods, such as sap pine.

There are only seventeen open tank or non-pressure plants worthy of mention in America, and some of these are hardly worth listing. For example, plant No. 10-a was built by the City of Cleveland only as an experiment, according to a report made by the City Engineer. He further states that the plant did not demonstrate any financial saving, as the city was able to buy treated timber at a lower cost than they could treat it themselves, and the tank was kept in operation for only a short period. On the Pacific Coast there are three or four small iron open tanks in which the butts of poles are boiled in Creosote Oil. In various parts of the country we find small open tanks, usually second-hand boilers or cylinders, with an opening cut along the upper side and place to kindle fire underneath. In these fence posts are boiled in the preservative.

However, the quantity of wood treated by the open tank and non-

pressure process is comparatively insignificant, perhaps it does not exceed one per cent. of all the material treated in this country.

The second method of impregnation is the one in general use. In this case the timber is placed in cylinders with closed ends and the preservative is injected into the wood under a pressure by the use of a force pump. There are some variations in the operation, but the principle is the same in all of them, namely, the injection of the fluid by the application of pressure.

The various methods or processes employed in America may be classed in five groups and described as follows:

Process "A"—(Bethel—Burnett—Lowry).

Ties, piling, timbers, poles, paving blocks, etc., are first air seasoned (that is, piled in open air for a period of three to twenty months), then run into cylinders and doors closed. The wood is then submerged in the preservative fluid, heated to a temperature of 170 to 190 degrees Fahr. before admission into the cylinders. Pressure pump is put into action, forcing more fluid into the cylinder. The operation is continued and maintained until the desired absorption is obtained. The pressure is then released, the surplus fluid drained from the cylinder and a vacuum is applied. This last operation is for the purpose of hastening the drying of the material. This completes the treating operation, and the material is then withdrawn from the cylinders. The above-described method is known as the Bethell Process (Pat. 1838) when using creosote oil, Burnett Process (Pat. 1838) when using Cloride of Zinc or Lowry Process (Pat. 1906) using creosote oil.

Process "B"—(Preliminary Steaming—Vacuum—Pressure.)

Ties, piling, timbers, poles, paving blocks, etc., green or partially seasoned, are run into cylinders and doors closed. Live steam is admitted at such rate as to secure 20 pounds of steam pressure within thirty to fifty minutes. This pressure is maintained for periods varying from one to five hours, depending upon the character of the timber and its condition, but the pressure, as indcated on the gauge, should not exceed twenty pounds. A vacuum is then applied and maintained for at least one-half hour, at the expiration of which time the preservative is admitted into the cylinder without otherwise breaking the vacuum. The wood is then submerged in a preservative fluid, heated to a temperature of 170 to 190 degrees Fahr., before admission into the cylinder. Pressure pump is then put in action, and the remainder of the operation is the same as process "A," above described. This process is quite old and has no patent claimants.

Process "C"—(Boulton—Curtis and Isaacs—Buehler.)

Ties, piling, timbers, poles, paving blocks, etc., green or partially seasoned, are run into a cylinder and door closed. The wood is then sub-

merged in a preservative fluid (usually Creosote Oil) and temperature raised to 215 to 225 degrees Fahr., and the boiling maintained for periods varying from four to eight hours, depending upon the character of the timber and its condition. A vacuum is sometimes applied to assist liberation of saps in the wood. Pressure pump is then put in action, and the remainder of the operation is substantially the same as process "A," above described. This method is called Boulton's Process (Pat. 1879), Curtis and Isaacs, (Pat. 1895), Buehler Process (Pat. 1908). This process is used extensively on the Pacific Coast for treatment of Douglas Fir.

Process "D"—(Rueping.)

Ties, piling, timbers, poles, paving blocks, etc., are first air seasoned, then run into a cylinder and door closed. An initial air pressure of varying intensity is applied, and without lowering this air pressure the cylinder is filled with a preservative (usually creosote oil) having a temperature of 170 to 190 degrees Fahr. Pressure pump is then put into action and the pressure raised still higher. The remainder of the operation is substantially the same as in process "A," above described. This method is known as the Reuping Process (Pat. 1902 and reissued in 1907). The patentees call it an "Empty cell" process. (*See foot note.*)

Process "E"—(Card.)

Creosote Oil and Zinc Chloride (a water solution) have different specific gravities, and therefore separate from each other unless kept in agitation. When it is desirable to use a mixture of these two preservatives for the treatment of wood, it is necessary to keep the solution in agitation in the treating cylinder while it is being forced into the wood. A device for this purpose has been invented and patented by Mr. Card. The emulsion of Zinc Chloride and Creosote Oil is made and forced into the wood in one operation. This is knwn as the Card Process (Pat. 1906).

Species of Wood Treated.

The varieties of wood treated are many, and depend to a large extent upon the kind of timber available in the locality of the treating plant. In order to facilitate replies the Association's circular letter of inquiry gave a list of woods in North America, as given below, to which we have prefixed an index number.

The reverse of this process is used at some treating plants; that is, instead of applying an initial air pressure, a preliminary vacuum is applied. The effect of this operation is to leave more of the fluid in the wood. Experiments described by Mr. Howard F. Weiss and published in the American Wood Preservers' Association proceedings, 1912, page 181, clearly indicate the effect of an initial air pressure or preliminary vacuum in wood upon its treatment.

Northern Forest.

100	White Pine	105	Birches	110	Tamarack
101	Red Pine	106	Hemlocks	111	Maples
102	Jack Pine	107	Beech	112	Ashes
103	Spruces	108	Chestnut	113	Cedars
104	Balsam Fir	109	Poplars	114	Aspens

Central Forest.

115	White Oak	122	Yellow Poplar	129	Buckeyes
116	Black Oak	123	Cherry	130	Cottonwoods
117	Red Oak	124	Ashes	131	Black Gum
118	Hickories	125	Elms	132	Sycamores
119	Chestnut	126	Maples	133	Butternut
120	Walnut	127	Beech		
121	Linden	128	Locust		

Southern Forest.

134	Long Leaf Yellow Pine	139	Juniper	146	Butternut
		140	Ashes	147	White Cedar
135	Short Leaf Yellow Pine	141	White Oak	148	Elms
		142	Black Oak	149	Osage
136	Loblolly Pine	143	Cypress	150	Honey Locust
137	Red Oak	144	Black Gum		
138	Hickories	145	Red Gum		

Rocky Mountain Forest.

151	Yellow Pine	154	Douglas Fir	157	Balsam Fir
152	Spruces	155	Junipers	158	Aspens
153	Cottonwoods	156	Oaks		

Pacific Coast Forest.

159	Douglas Fir	163	Cottonwoods	169	Birches
160	Western Red Cedar	164	Spruces	170	Redwood
		165	Hemlocks	171	Cedars
161	Yellow Pines	166	White Pines	172	Larches
162	Balsam Fir	167	Junipers	173	Alders
		168	Maples		

Tropical Forest (Mexico).

174	Pines	177	Mesquite	181	Ash
175	Mulberry	178	Elm	182	Cottonwood
176	Linden	179	Sycamore	183	Mora
		180	Ceiba		

Most all species of wood in America are susceptible to treatment and the useful life of same can be greatly increased by proper treatments.

Kind of Material Treated.

The chief item is railroad ties. perhaps constituting no less than ninety per cent. of all the wood treated in America; the remaining ten per cent. consists of several items. The Association's circular letter of inquiry gave a list of the principal kinds of material treated as shown below and to which an index number has been prefixed to to each item, as follows:

200	Railroad Ties	204	Switch Ties	209	Wooden Pipe
201	Piling	205	Cross Arms	210	Crossing Plank
202	Telegraph Poles	206	Mine Props	211	Signal Poles and
203	Dimension Timbers	207	Fence Posts	212	Tie Plugs
		208	Paving Blocks		

Capacity of Plants.

The capacity of a treating plant depends primarily upon the size and number of impregnating cylinders. There are four prime factors which affect the number of ties that can be treated with a given cylinder, namely:

(1) Length and size of ties.
(2) Whether steamed and impregnated in the same cylinder or in separate cylinders.
(3) Number of hours daily that the plant is in operation.
(4) Whether or not the plant is in continuous operation throughout all seasons of the year.

Ties vary in length, some containing as little as two and one-half cu. ft., while some contain as much as three and three-quarters cu. ft. of timber and it is obvious that the number of ties that can be loaded on a tram varies with their size, besides this, a given cylinder will not hold as many trams of ties 8½ feet long as it would ties 8′ long.

If ties are steamed and impregnated in the same cylinder (Process "B") obviously a less number of ties can be treated in a given cylinder. Let us suppose that the time required to steam the ties be an average of four hours and for simple impregnation (Process "A") four hours also, then it would be possible to treat only three charges of ties every twenty-four hours when steamed and impregnated or six charges if impregnated only.

If the plant is not operated continuously day and night (except Sundays) the number of ties treated would be proportionately less or in proportion to the number of hours the plant is in operation.

Finally, if the plant is closed down during the Winter months of the year, as is frequently necessary in Northern latitudes, the output is correspondingly decreased.

Other allowances have to be made for breakdowns and unexpected interruptions in the operation of the works.

In order to find the ratio between the cubical measurements of cylinders and their treating capacity, let us take two cylinders seven feet

diameter, one hundred feet long and suppose that railroad ties are simply impregnated in the usual way (Process "A") the schedules would be as follows:

Daily run hours.	No. of charges.	No. of 6′ x 8 x 8′ ties.	No. of 7x8x8½ ties.
4	1	564	517
6	2	1128	1034
8	3	1692	1551
10	4	2256	2068
12	5	2820	2585
14	6	3384	3102
16	7	3948	3619
18	8	4512	4136
20	9	5076	4653
22	10	5640	5170
24	12	6768	6204

300 days 6768 8 ′ ties per day = 2,030,400 ties.
300 days 6204 8½′ ties per day= 1,861,200 ties.

If ties are given a preliminary steaming, (Process "B") the number treated annually would be reduced about half, as it takes about as many hours to steam them as it does to impregnate with the preservative.

In either case it would be very improbable that the maximum number of ties above stated could be treated annually and the amounts should be liberally reduced, just how much would depend on many factors, principally, the four above mentioned. In our opinion, the reduction should be on an average of about fifty per cent.; in other words, with two cylinders of size above mentioned, an average of 1,000,000 ties would be treated annually by Process "A". As these two cylinders have a volume of 7696 cu. feet, the ratio would be 130 ties per cubic foot of cylinder volume and this is the common factor which we have used in computing the capacity of treating plants given in the accompanying list. This factor may be increased or decreased and the author leaves it to the reader to assume whatever figure he pleases, but in doing so, it should be made applicable to all plants in estimating their relative capacities, for as above stated, the capacity of a treating plant depends primarily upon the size and number of cylinders.

Several plants contemplate enlarging their works by increasing the length or number of cylinders, but in the report we have given the capacity of plant, based on cylinders in actual operation. The report distinguishes those plants that do commercial work from those which treat for certain railroads exclusively. As a rule, plants owned and operated by railroad companies treat for their lines exclusively and do not handle any commercial work of any kind for outside parties.

Growth of the Industry.

In 1885 there were only five Pressure plants in operation in America.

The number gradually increased from year to year. In 1890 there were eight plants, in 1895, twelve plants, in 1900, fifteen plants, in 1905, thirty-four plants, in 1910, seventy-five plants and at the end of the year 1912, eighty-four plants in operation and six under construction. During the past twelve years the increase in number of plants in United States has been at the rate of six plants a year. There are four plants in Canada and two in Mexico.

At the end of the year 1903, there were twenty-seven plants in operation, with an aggregate capacity of 21,000,000 ties per annum, or its equivalent in timber and other material, while at the end of the year 1912 there were eighty-four plants in operation with an aggregate capacity of 97,904,000 ties per annum. Thus the number of plants was trebled and capacity quadrupled during the past nine years. This is a marvelous growth and there is every reason to believe that the industry will continue to grow from year to year until the bulk of the cross ties used in this country shall receive a preservative treatment.

The accompanying map shows the location of all the Pressure plants as well as the Forest Regions of North America. They seem numerous but there is room and need for more.

LIST OF WOOD-PRESERVING PLANTS IN THE UNITED STATES, CANADA AND MEXICO, JANUARY 1st, 1913.

PRESSURE PROCESS.

EASTERN STATES.

Plant No. Reference.	Map Reference.	Location.	Managing Company.	Address.	Year built.	No. of Cylinders.	Dia., inches.	Length, ft.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. ties.
1	C14	Long Island City, N. Y.	Eppinger & Russell Co.	New York, N. Y.	1878	4	72	100	11,312	1,470,000
2	B14	Rome, N. Y.	Federal Creosoting Co.	Louisville, Ky.	1910	2	84	150	11,550	1,495,000
3	C14	Bound Brook, N. J.	Federal Creosoting Co.	Louisville, Ky.	1909	1	84	150	5,775	750,000
4	C14	Newark, N. J.	American Creosoting Co.	New York, N. Y.	1906	2	78	105	6,972	905,000
5	C14	Paterson, N. J.	Federal Creo. Co.	Louisville, Ky.	1909	1	84	150	5,775	750,000
6	C14	Maurer, N. J.	Barber Asphalt Pav. Co.	Maurer, N. J.	1905	4	72	115	13,008	1,690,000
7	C13	Port Reading, N. J.	P. & R. R. R., C. R. R. of N. J.	Port Reading, N. J.	1912	2	88	140	11,368	1,475,000
8	C13	Greenwich, Pa.	Penna. R. R.	Philadelphia, Pa.	1910	2	72	132	7,466	970,000
9	C13	Mt. Union, Pa.	Penna. R. R.	Philadelphia, Pa.	1909	1	72	132	3,733	485,000
10	C13	Broadford Jc., Pa.	Pittsburgh Wd. Pres. Co.	Pittsburgh, Pa.	1911	1	84	132	4.082	530,000
11	C13	Bradford, Pa.	Buff., Roch. & Pgh. R. R.	Rochester, N. Y.	1910	1	75	95	2,914	365,000
12	E13	Buell, near Norfolk, Va.	U. S. Wood Pres. Co.	New York, N. Y.	1907	2	78	150	9,960	1,295,000
13	E13	Buell, near Norfolk, Va.	Norfolk Creosoting Co.	Norfolk, Va.	1896	4	78	100		
						1	78	105		
					1905	1	84	125	21,578	2,800,000
14	E13	Norfolk, Va.	Atlantic Creo. & Wood Preserving Works.	Norfolk, Va.		1	78	62		
						1	78	82		
					1901	1	78	126	8,964	1,165,000
15	E13	Portsmouth, Va.	Wyckoff Pipe & Creo. Co.	50 Church St., New York	1881	4	74	102	13,000	1,690,000
16	D13	Green Spring, W. Va.	Balto. & Ohio. R. R.	Baltimore, Md.	1912	2	84	132	10,198	1,325,000

Plant No. Reference.	Map Reference.	Location.	Managing Company.	Address.	Year built.	No. of Cylinders.	Dia., inches.	Length, ft.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. ties.
17	H12	Gainesville, Fla.	Atlantic Coast Line R. R.	Wilmington, N. C.	1912	2	74	138	8,252	1,070,000
18	G11	Pensacola, Fla.	Southern Pav. Con. Co.	Chattanooga, Tenn.	1912	1	72	90	2,545	330,000
19	G12	Jacksonville, Fla.	Eppinger & Russell Co.	New York, 168 Broadway	1909	3	84	130	15,015	1,950,000
20	I12	Hull, Fla.	Charlotte Harbor and Nor. Ry. Co.	Boca Grande, Fla.	1912	1	74	73	2,182	285,000
21	F12	Macon, Ga.	Central of Ga. R. R. Co.	Macon, Ga.	1912	2	84	116	8,932	1,160,000
22	F12	Atlanta, Ga.	Southern Wd. Pres. Co.	Atlanta, Ga.	1908	1	72	70	1,960	255,000
23	F12	Ensley, Ala.	Pioneer Lum. & Creo. Co.	Ensley, Ala.	1911	1	74	76	2,272	295,000
24	G11	Mobile, Ala.	Republic Creosoting Co.	Indianapolis, Ind.	1906	2	74	130	7,774	1,010,000
25	F11	McAdory, Ala.	Tennessee Coal, Iron and Railroad Co.	Birmingham, Ala.	1909	1	72	65	1,838	240,000
26	H10	Southport, near New Orleans, La.	American Creosote Wks.	New Orleans, La.	1901	1 1	84 108	172 172	17,557	2,275,000
27	H10	New Orleans, La.	New Orleans Wd. Pr. Co.	River & Lyon Sts., New Orleans, La.	1888	1	72	125	3,535	460,000
28	G11	Slidell, La.	Southern Creosoting Co.	Slidell, La.	1879 1902	1 2	84 72	150 100	11,431	1,480,000
29	G10	Shreveport, La.	Shreveport Creo. Co.	Amer. Creo. Co., Louisville, Ky.	1910	2	84	134	10,318	1,340,000
30	G10	Winnfield, La.	Louisiana Creo. Co.	Winnfield, La.	1906	1 1	72 72	126 80	5,825	755,000
31	G11	Bogalusa, La.	Colonial Creo. Co.	American Creo. Co., Louisville, Ky.	1912	2	72	134	7,578	985,000
32	F11	Grenada, Miss.	Ayer & Lord Tie Co.	Chicago, Ill.	1904	4	74	128	15,308	1,990,000

SOUTHERN STATES.

Plant No. Reference.	Map Reference.	Location.	Managing Company.	Address.	Year built.	No. of Cylinders.	Dia., inches.	Length, ft.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. ties.
33	G11	Gulfport, Miss.	Gulfport Creo. Co.	Gulfport, Miss.	1906	2	84	120	9,240	1,210,000
34	G11	Gautier, Miss.	W. Pascagoula Creo. Wks	L. & N. R. R., Louisville, Ky.	1876	1	72	119		
					1903	2	72	115	9,870	1,285,000
35	F11	Louisville, Miss.	American Creo. Wks.	New Orleans, La.	1912	1	108	172	10,939	1,415,000
36	F10	Argenta, Ark.	Ayer & Lord Tie Co.	Chicago, Ill.	1907	4	74	132	15,788	2,050,000
37	F10	Texarkana, Ark.	Int. Creo. & Con. Co.	Galveston, Tex.		1	114	165		
					1902	1	72	125	15,230	1,975,000
38	G10	Beaumont, Tex.	Int. Creo. & Con. Co.	Galveston, Tex.	1892					
					1897	1	108	140	8,905	1,155,000
39	F9	Denison, Tex.	Mo. Kan & Tex. Ry. Co. of Texas.	St. Louis, Mo.	1909	4	72	108	12,216	1,585,000
40	F10	Texarkana, Tex.	Nat. Lum. & Creo. Co.	Texarkana, Ark.	1910	2	84	132	10,164	1,320,000
41	H9	Houston, Tex.	Nat. Lum. & Creo. Co.	Texarkana, Ark.	1912	4	72	120	13,574	1,765,000
42	H9	Houston, Tex.	Tex. & N. O. R. R. Co.	Houston, Tex.	1890	5	72	112	15,835	2,055,000
43	G9	Somerville, Tex.	A., T. & S. F. R. R.	Topeka, Kan.	1906	5	74	132	19,734	2,560,000
44	F9	Hugo, Okla.	American Creo. Co.	Louisville, Ky.	1907	2	84	134	10,318	1,340,000

CENTRAL STATES.

45	C12	Toledo Ohio.	Federal Creo. Co.	Louisville, Ky.	1909	3	84	134	15,477	2,000,000
46	C12	Toledo Ohio.	Jennison-Wright Co.	Toledo, Ohio.	1910	2	72	130	7,352	955,000
47	C12	Orrville, Ohio.	Ohio Wood Pres. Co.	Pittsburgh, Pa.	1912	1	84	132	5,080	660,000
48	D12	Cincinnati, Ohio.	Comp. Wd. Pres. Co.	Cincinnati, Ohio.	1909	1	72	76	2,150	280,000

CENTRAL STATES.

Plant No. Reference.	Map Reference.	Location.	Managing Company.	Address.	Year built.	No. of Cylinders.	Length, ft.	Dia., inches.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. ties.
49	D11	Indianapolis, Ind.	Republic Creo. Co.	Indianapolis, Ind.	1903	1	74	130	3,887	505,000
50	D11	Shirley, Ind.	American Creo. Co.	Louisville, Ky.	1905	2	84	134	10,318	1,340,000
51	D11	Terre Haute, Ind.	Indiana Zinc-Creo. Co.	Terre Haute, Ind.	1904	2	72	120	6,787	880,000
52	D11	Terre Haute, Ind.	Chicago Creosoting Co.	Chicago, Ill.	1912	2	132	20	3,800	485,000
53	D11	Bloomington, Ind.	Indiana Creosoting Co.	Louisville, Ky.	1907	1	84	134	5,159	670,000
54	D11	Columbus, Ind.	Indianapolis, Columbus & Southern Trac. Co.	Indianapolis, Ind.	1909	1	72	45	1,272	165,000
55	D11	Evansville, Ind.	Indiana Tie Co.	Evansville, Ind.	1907	2	72	110	6,220	810,000
56	C11	Waukegan, Ill.	Chicago Creosoting Co.	Chicago, Ill.	1907	2	72	134	7,578	985,000
57	D11	Carbondale, Ill.	Ayer & Lord Tie Co.	Chicago, Ill.		4	72	122		
					1902	4	74	132	29,587	3,850,000
58	D11	Marion, Ill.	American Creo. Co.	Louisville, Ky.	1907	2	84	134	10,318	1,340,000
59	D10	Madison, Ill.	Kettle River Co.	Minneapolis, Minn.	1909	4	84	135	20,790	2,700,000
60	C10	Galesburg, Ill.	C., B. & Q. R. R.	Galesburg, Ill.	1907	5	74	132	19,734	2,560,000
61	D11	Mt Vernon, Ill.	T. J. Moss Tie Co.	St. Louis, Mo.		1	74	132		
					1899	1	72	117	7,255	940,000
62	E11	Joppa, Ill.	Indiana Tie Co.	Evansville, Ind.	1909	2	72	110	6,220	810,000
63	B12	Bay City, Mich.	Michigan Pipe Co.	Bay City, Mich.	1893	1	72	42	1,188	155,000
64	A11	Escanaba, Mich.	Chi. & N. W. Ry. Co.	Chicago, Ill.	1903	3	72	112	9,472	1,230,000

CENTRAL STATES.

Plant No. Reference.	Reference. Map	Location.	Managing Company.	Address.	Year built.	No. of Cylinders	Length, ft.	Dia., inches.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. ties
65	A10	Minneapolis, Minn.	Republic Creosoting Co.	Minneapolis, Minn.	1905	2	74	130	7,774	1,010,000
66	A10	Sandstone, Minn.	Kettle River Co.	Minneapolis, Minn.	1904	2	72	120	6,787	880,000
67	A10	Brainerd, Minn.	Nor Pac. Ry.	St. Paul, Minn.	1907	2	84	134	10,318	1,340,000
68	E10	Springfield, Mo.	American Creo. Co.	Louisville, Ky.	1907	2	84	134	10,318	1,340,000
69	D10	Kansas City, Mo.	American Creo. Co.	Louisville, Ky.	1907	2	84	134	10,318	1,340,000
70	D9	Topeka, Kansas.	Union Pacific R. R.	Omaha, Neb.	1909	2	73	117	6,800	885,000
			ROCKY MOUNTAIN AND PACIFIC STATES.							
71	A6	Somers, Mont.	Great Nor. Ry. Co.	St. Paul, Minn.	1901	4	72	110	12,442	1,610,000
72	A6	Paradise, Mont.	Nor. Pac. Ry. Co.	St. Paul, Minn.	1907	2	84	134	10,318	1,340,000
73	A6	Butte, Mont.	Anaconda Cop. Min. Co.	Butte, Mont.	1910	1	72	43	1,216	160,000
74	B7	Sheridan, Wyo.	C., B. & Q. R. R. Co.	Chicago, Ill.	1899	2	74	132	7,894	1,025,000
75	C7	Laramie, Wyo.	Union Pacific R. R. Co.	Omaha, Neb.	1903	2	73	117	6,800	885,000
76	A5	Kellogg, Idaho.	Bunker Hill and Sullivan Mining Co.	Kellogg, Idaho.	1908	1	84	10	385	50,000
77	A4	Tacoma, Wash.	S.t P. & Tacoma Lum. (	Tacoma, Wash.	1912	1	84	130	5,005	650,000
78	A4	Yardley, Wash.	Western Wd. Pres. Co.	615 Peyton Bldg, Spokane, Wash.	1912	1	84	65	2,502	325,000
79	A4	Lowell, Wash.	Puget Sd. Wd. Pres. Co.	Lowell, Wash.		1	84	117		
						1	72	83		
					1895	1	72	52	8,322	1,080,000
80	A4	Seattle, Wash.	J. M. Colman Co.	Seattle, Wash.	1884 1912	3	75	120	11,043	1,430,000

ROCKY MOUNTAIN AND PACIFIC STATES.

Plant No. Reference.	Map Reference.	Location.	Managing Company.	Address.	Year built.	No. of Cylinders	Length, ft.	Dia., inches.	Volume, cu. ft.	Capacity per an. 6 in. x 8 in. 8 ft. Ties.
81	A4	Eagle Harbor, Wash.	Pacific Creosoting Co.	Eagle Harbor, Wash.	1906	8	73	125	29,060	3,770,000
82	A4	Wyeth, Ore.	Oregon-Washington R. R. and Nav. Co.	Portland, Ore.	1904	4	72	114	12,995	1,690,000
83	A4	St. Helens, Ore.	St. Helens Creo. Co.	St. Helens, Ore.	1912	2	84	136	10,472	1,360,000
84	B4	Latham, Ore.	Southern Pac. R. R.	San Francisco, Cal.	1893	2	72	112	6,334	825,000
85	A4	Burlington (near Portland), Ore.	Columbia Creo. Co.	809 Lewis Bldg., Portland, Ore.	1912	1	72	65	1,838	240,000
86	F7	Alamogordo, N. Mex.	El Paso & S. W. R. R. Co	El Paso, Tex.	1902	2	72	106	5 995	780,000
87	E7	Albuquerque, N. M.	A. T. & S. F. Ry. Co.	Topeka, Kansas.	1908	2	74	132	7,894	1,025,000
88	D4	Oakland, Cal.	So. Pacific Ry.	San Francisco, Cal.	1889	1	72	108	6,956	900,000
89	F5	Los Angeles, Cal.	So. Pacific Ry.	San Francisco, Cal.	1907	2	72	112	6,334	825,000
90	F5	San Pedro, Cal.	S. P. L. A. & S. L. R. R.	Los Angeles, Cal.	1908	2	72	117	6,617	860,000
					Grand Total.....					103,369,000

CANADA.

91	A11	St. Francis, Ont.	Alex. Bruce & Co.	Glasgow, Scotland.	1912	1				
92	A9	Transcona, near Winnipeg, Man.	Dominion Tar and Chem. Co., Ltd.	Sydney, N. S.	1912	1 3	78 78	84 135	16,225	2,110,000
93	A16	Sydney, N. S.	Dominion Tar and Chem. Co., Ltd.	Sydney, N. S.	1911	1				
94	A4	Vancouver, B. C.	Dominion Creo. Co.	Vancouver, B. C	1910	2				

EASTERN STATES.

Plant No Reference.	Map Reference.	Kinds of Wood Treated.	Kind of Material Treated	Preservative Used.	Plant equipped to treat by process.	Commercial Works.	Remarks.
1	C14	103 108 115 119 134 135 136	200 201 202 203 204 205 210	Creosote	A	Yes	
2	B14	105 107 111 116 117 126 127 134 135 136	200 204	Creosote	A	No	
3	C14	116 117 134 135 136	200 201 203 204	Creosote	A	Yes	
4	C14	134 135 136	200 201 203 204	Creosote	A	Yes	
5	C14	115 116 117 119 127 134 135 136	200 201 203 204 210	Creosote	A	No	
6	C14	100 103 106 115 116 117 134 135 136 159	200 201 202 203 204 205 207 208 210	Creosote Water GasTar	A and B	Yes	
7	C13	115 116 117 118 122 124 125 126 127 132 134 135 136 137 138 140 141 142 144 148	200 201 203 204	Creosote	A	No	
8	C13	105 107 111 116 117 126 127 131 134 135 136 144	200 201 202 203 204 205 207 208 209 210 211	Creosote	A and D	No	
9	C13	105 107 111 117 126 127 134 135 136	200 201 202 203 204 205 207 208 209 210 211	Creosote	A and D	No	
10	C13	115 116 117 118 119 125 126 127 132	200 201 204 208 210	Creosote Chl. Zinc	A, D and E	Yes	
11	C13	105 116 117 118 119 123 125 126 127 131	200 204 210 212	Creosote	A	No	

EASTERN STATES

Plant No Reference.	Map Reference	Kinds of Wood Treated.	Kind of Material Treated	Preservative Used.	Plant equipped to treat by process.	Commercial Works.	Remarks.
12	E13	131 134 135 136 144	208	Creosote	A	Yes	Treat Paving Blocks
13	E13	131 134 135 136 137 139 141 144	200 201 202 203 204 205 207 209 210	Creosote	A and B	Yes	
14	E13	134 135 136 137 144 145	200 201 202 203 204 205 207 209 210	Creosote	A and B	Yes	
15	E13	134 135 136	200 201 202 203 204 205 207 208 209 210	Creosote	A	Yes	
16	D13	116 117 124 125 126 127 133 137 142	200 204	Creosote Chl. of Zinc	A, B and E	No	Under construction.

SOUTHERN STATES.

17	H12	134 135 136	200	Creosote	A	No	
18	G11	134 135 136	200 201 202 203 204 205 206 207 208 210	Creosote	A	Yes	
19	G12	134 135 136	200 201 202 203 204 205 207 208 210	Creosote	A	Yes	
20	G12	134 135 136 143	200 201 203 204 207 210	Creosote	A and D	Yes	Under construction.
21	G12	121 134 135 136 144	200 201 202 203 204 210	Creosote Chl of Zinc	A and D	No	
22	F12	117 134 135 136 137	200 202 203 204 205 207 208	Creosote	A	Yes	

SOUTHERN STATES.

Plant No. Reference	Map Reference	Kind of Wood Treated	Kind of Material Treated	Preservative Used	Plant equipped to treat by process	Commercial Works	Remarks
23	F11	134 135 136	200 201 202 203 204 207 208	Creosote	A	Yes	
24	G11	134 135 136 137 141 142 144	200 201 202 203 204 205 206 207 208 210	Creosote	A	Yes	
25	F11	134 135 136	200 202 203 207	Creosote	A	No	
26	H10	134 135 136 137 144 145	200 201 202 203 204 205 207 208 210	Creosote	A and D	Yes	
27	H10	134 135 136	200 201 202 203 204 205 207	Creosote	A and D	Yes	
28	G11	134 135 136 143	200 201 202 203 204 205 206 207 208 209 210	Creosote	A and B	Yes	
29	G10	134 135 136 137 142	200 201 202 203 204 210	Creosote	A	Yes	
30	G10	134 135 136 137 145	200 201 202 203 205	Creosote	A and B	Yes	
31	G11	134 135 136 137 142	200 201 203 204 210	Creosote	A	Yes	
32	J11	134 135 136 137 143 144	200 201 202 203 204 207 208 210	Chl. of Zinc Creosote	A, B and D	Yes	
33	G11	134 135 136	200 201 202 203 204 205 207 208 210	Creosote	A, B and D	Yes	
34	G11	134 135 136	201 202 203 204 205 207 208 209	Creosote	A and B	No	

SOUTHERN STATES

Plant Reference	Map Reference	Kinds of Wood Treated	Kind of Material Treated	Preservative Used	Plant equipped to treat by process	Commercial Works	Remarks
35	F11	134 135 136 137 144 145	200 201 202 203 204 205 207 208 210	Creosote	A and D	Yes	Under construction.
36	F10	116 117 124 125 127 128 131 134 135 136 137 140 142 144	200 201 202 203 204 208 210	Creosote Chl. of Zinc	A, B and D	Yes	
37	F10	134 135 136 137	200 201 202 203 204 205 206 207 208 210	Creosote Chl. of Zinc	A and B	Yes	
38	G10	134 135 136 137	200 201 202 203 204 205 206 207 208 210	Creosote Chl. of Zinc	A and B	Yes	
39	F9	123 130 134 135 136 140 141 142 143 144 145 146 147 148 150 153	200 201 203 204 205 207 210	Creosote	A and D	No	
40	F10	116 117 134 135 136 137 142 144 145	200 201 202 203 204 207 208 210	Creosote Chl. of Zinc	A, B, D & E	Yes	
41	H9	134 135 136 137 142 144 145	200 201 202 203 204 205 207 208 210	Creosote Chl. of Zinc	A, B and D	Yes	
42	H9	134 135 136	200 201 203 204 211	Creosote Chl. of Zinc	A and B	No	
43	G9	115 117 125 131 132 134 135 136 137 141 144 145 148	200 201 203 204 210	Creosote	A and D	No	
44	F9	134 135 136 137 138 142 144 145 148	200 201 203 204	Creosote	A	No	

Plant No. Reference.	Map Reference	Kinds of Wood Treated.	Kind of Material Treated	Preservative Used.	Plant equipped to treat by process.	Commercial Works.	Remarks.
45	C12	105 116 117 124 125 126 127	200 201 203 204 210	Creosote	A	No	
46	C12	102 105 106 107 109 110 111 112 113 116 117 118 120 124 125 126 127 128 131 134 135 136	200 201 202 203 204 205 207 208 210	Creosote Chl. of Zinc	A and B	Yes	
47	C12	115 116 117 118 119 125 126 127 132	200 204	Creosote Chl. of Zinc	A, D and E	Yes	
48	D12	115 116 117 127 134 135 136 141 142	200 203 204 208	Creosote Crude Oil	A	Yes	
49	D11	134 135 136 137 141	200 203 204 205 207 208 210	Creosote	A	Yes	
50	D11	116 117 118 124 125 126 127 131 132	200 201 203 204	Creosote	A	No	
51	D11	116 117 125 126 127 134 135 136 159	200 201 203 204 205	Creosote Chl. of Zinc	A, B and E	Yes	
52	D11	134 135 136 208	208	Chl. of Zinc Creosote	A	Yes	Under construction For paving blocks only
53	D11	116 117 118 119 124 125 126 127	200 201 202 203 204 208 210	Creosote	A	Yes	
54	D11	116 117 118 119 121 122 123 124 126 127 131 132 133	200 202 203 204 205 207 210 200	Creosote	A	No	
55	D11	116 117 118 122 124 125 126 127 131 132 133 144	200	Chl. of Zinc Creosote	A and B	Yes	

CENTRAL STATES

Plant Reference	Map Reference	Kinds of Wood Treated	Kind of Material Treated	Preservative Used	Plant equipped to treat by process	Commercial Works	Remarks
56	C11	106 107 110 111 117 126 127 134 135 136 137	200 201 203 204 208	Creosote Chl. of Zinc	A, B and C	Yes	
57	D11	115 116 117 118 119 124 125 127 131 132	200	Creosote Chl. of Zinc	A, B and D	Yes	
58	D11	127 134 135 136 137 142 144 145 148	200 201 202 203 204 208 210	Creosote	A	Yes	
59	D10	116 117 119 125 126 127 128 132 133 134 135 136 137 142 143 154 157 159	200 201 202 203 204 205 206 207 208 209 210	Creosote Chl. of Zinc	A, B, C & E	Yes	
60	C10	105 106 107 110 111 112 116 117 118 119 120 122 123 124 125 126 127 129 130 131 132 133 134 135 136 137 138 140 142 143 144 148 159	200 201 203 204 208 209 210	Creosote Chl. of Zinc	A, B and E	No	
61	D11	116 117 118 124 125 126 127 131 134 135 136	200 201 204	Creosote Chl. of Zinc	A, B and E	Yes	
62	E11	116 117 118 122 124 125 126 127 131 132 133 144	200	Creosote Chl. of Zinc	A and B	Yes	
63	B12	101 102 105 106 107 110 111	203 210	Creosote	A	Yes	
64	A11	105 106 107 110 111	200 201 203 204	Creosote Chl. of Zinc	A. B and E	No	

CENTRAL STATES.

Plant Reference	Map Reference	Kinds of Wood Treated	Kind of Material Treated	Preservative Used	Plant equipped to treat by process	Commercial Works	Remarks
65	A10	100 101 102 103 106 110 111 113 134 135 136 154 159 160 172	200 201 202 203 204 207 208 210	Creosote	A	Yes	
66	A10	100 101 102 103 104 105 107 110 111	200 201 204	Creosote Chl. of Zinc	A, B and C	Yes	
67	A10	102 105 110 111 116 117	200 203 204 208 212	Creosote	A	No	
68	E10	116 117 124 125 126 127 134 135 136 145	200 201 203 204	Creosote	A	No	
69	D10	116 117 125 127 134 135 136	200 201 203 204	Creosote	A	No.	
70	D9	116 117 125 127 134 135 136	200 201 203 204	Chl. of Zinc	A and B	No	

ROCKY MOUNTAIN AND PACIFIC STATES.

71	A6	100 103 110 151 152 154 159 161 166 172	200 203 204 208	Chl. of Zinc	A and B	No	
72	A6	151 154 157 165 172	200 203 212	Creosote	A	No	
73	A6	151 154 159	200 204 206	Creosote	A	No	
74	B7	102 103 106 110 159	200	Chl. of Zinc	A and B	No	
75	C7	102 103 106 110 159	200	Chl. of Zinc	A and B	No	
76	A5	159 160 161 162	206	Creosote	A	No	

ROCKY MOUNTAIN AND PACIFIC STATES.

Plant No Reference	Map Reference.	Kinds of Wood Treated.	Kind of Material Treated	Preservative Used.	Plant equipped to treat by process.	Commercial Works.	Remarks.
77	A4	159 171	200 201 202 203 204 205 206 207 208	Creosote	A and C	Yes	
78	A4	159 161 162	200 201 202 203 204 210	Creosote	A	Yes	Under construction.
79	A4	159 161 165 166 171	200 201 202 203 204 205 208 210	Creosote	A, B and C	Yes	
80	A4	159	200 201 203 204 208 210	Creosote	A and B	Yes	
81	A4	159	200 201 203 204 205 207 208 209 210	Creosote	A and C	Yes	
82	A4	159	200 201 203 204 208	Creosote Chl. of Zinc	A and C	No	
83	A4	159	200 201 202 203 204 210	Creosote	A and C	Yes	Under construction.
84	B4	159	200 201 202 203 204 208	Creosote Chl. of Zinc	A, B and C	No	
85	A4	159 165	200 204 205 207 208 209 210	Creosote	A, B and C	Yes	Under construction.
86	F7	101 151 154	200	Creosote	A and D	No	
87	E7	151 152 154 157	200 201 203 204 210	Crude Oil Creosote	A and C	No	
88	D4	159	200 201 203 204 205 208 209 210	Creosote Chl. of Zinc	A, B and C	No	
89	F5	159	200 204	Chl. of Zinc	A and B	No	
90	F5	159	200 201 203 204	Creosote Chl. of Zinc	A, B and C	Yes	

CANADA.

Plant No. Reference	Map Reference	Kinds of Wood Treated	Kind of Material Treated	Preservative Used	Plant equipped to treat by process	Commercial Works	Remarks
91	A11	101 102 103 104 105 106 107 108 110 111 112	200 201 203 204 210	Chl. of Zinc	A and B	Yes	
92	A9	101 102 103 104 105 106 107 108 110 111 112	200 201 203 204 210	Creosote	A and B	Yes	
93	A16	101 102 103 104 105 106 107 108 110 111 112	200 201 203 204 210	Creosote	A and B	Yes	
94	A4	159 160 161 162	200 201 202 204 210	Creosote	A, B and C	Yes	

MEXICO.

Have no data regarding treating plants in Mexico. The Mexican Central Railroad built a plant at Aguas Calientas, Mexico (K8) in 1901 to treat railroad ties with chloride of zinc. About the year 1907 the Madero Company built a two-cylinder plant at Maderoa, Chihuahua, Mexico (H7) to treat railroad ties with chloride of zinc.

OPEN TANK OR NON-PRESSURE PROCESS PLANTS.

Plant No. Reference.	Location.	Managing Company.	Address.	Year built.	No. of tanks or boilers.	Size.	Capacity 6x8x8 ft. ties.
1a	Lowell, Mass.	Otis Allen & Son.	Lowell, Mass.	1848	2	4 ft. x 8 ft. x 50 ft.	30,000
2a	Portsmouth, N. H.	Otis Allen & Son.	Lowell, Mass.	1875	4	4 ft. x 8 ft. x 50 ft.	40,000
3a	Nanticoke, Pa.	Del, Lack & West. R. R. Coal Mining Dept.	Scranton, Pa.	1907	1	6 ft. dia. x 32 ft.	100,000
4a	New Philadelphia, Pa.	Phila. and Reading Coal and Iron Co.	Pottsville, Pa.	1908	1	6 ft. dia. x 32 ft.	100,000
5a	New Orleans, La.	Reeves Co.	New Orleans, La.	1910	1	4 ft. x 4 ft. x 30 ft.	20,000
6a	Keokuk, Iowa.	U. S. Wood Pres. Plant.	Keokuk, Iowa.	1908	1	4 ft. x 3 ft. x 42 ft.	25,000
7a	Milan, Ill.	U. S. Wood Pres. Plant.	Milan, Ill.	1908	1	4 ft. x 3 ft. x 42 ft.	25,000
8a	Stillwater, Minn.	U. S. Wood Pres. Plant.	Stillwater, Minn.	1908	1	4 ft. x 3 ft. x 42 ft.	25,000
9a	Fountain City, Wis.	U. S. Wood Pres. Plant.	Fountain City, Wis.	1908	1	4 ft. x 3 ft. x 42 ft.	25,000
10a	Cleveland, Ohio.	City of Cleveland.	Cleveland, Ohio.	1909	1	4 ft. x 3½ ft.x42 ft.	25,000
11a	Lead, S. Dak.	Homestake Mining Co.	Lead, S. Dak.	1908	1	4 ft. dia. x 38 ft.	50,000
12a	Portland, Ore.	Carbolineum W. P. Co.	Portland, Ore.	1910	1	3 ft. x 4 ft. x 60 ft.	30,000
13a	Lowell, Wash.	Puget Sound W. P. Co.	Lowell, Wash.	1895	2	6 ft. x 10 ft. x 36 ft.	50,000
14a	Butte, Mont.	Anaconda Cop. Min. Co.	Butte, Mont.	1909	1	10 ft. x 10 ft. x 10 ft.	25,000
15a	Fresno, Cal.	San Joaquin Light and Power Co.	Fresno, Cal.	1910	2	7 ft. x 9 ft. x 9 ft.	50,000
16a	San Miguel, Cal.	San Joaquin Light and Power Co.	Fresno, Cal.	1910	1	7 ft. x 9 ft. x 9 ft.	25,000
17a	Oakland, Cal.	So. Pac. Ry. Co.	San Francisco, Cal.	1889	1	4 ft. x 6 ft. x 8 ft.	20,000
						Grand Total.....	665,000

OPEN TANK OR NON-PRESSURE PROCESS PLANTS.

Plant Reference	Kinds of Wood Treated	Kind of Material Treated	Preservative Used	Process	Commercial Works	Remarks
1a	101 102 103 106 107 108 110	200 201 203 207 210	Chloride of Mercury	Immersion	Yes	
2a	101 102 103 106 107 108 110	200 201 203 207 210	Chloride of Mercury	Immersion	Yes	
3a	100 102 103 106 108 134 135 136	200 202 203 204 205 206 207 208	Creosote	Boiling	No	
4a	134 135 136	206	Chl. of Zinc Creosote	Boiling	No	
5a	134 135 136	200	Creosote	Boiling	No	
6a	134 135 136 143 144	204	Creosote	Immersion	No	
7a	134 135 136 143 159	204	Creosote	Immersion	No	
8a	134 135 136 143 159	204	Creosote	Immersion	No	
9a	134 135 136 143 159	204	Carbolineum	Boiling	No	
10a	134 135 136	204 208 210				
11a	151	200 201 203 205 210	Creosote	Boiling	No	
12a	159	200 202 203 208 210	Carbolineum	Boiling	Yes	
13a	159	202	Creosote	Boiling	Yes	For poles only.
14a	159	202	Creosote	Boiling	No	For poles only.
15a	160 161	203	Creosote	Boiling	No	For butts of poles only
16a	160 161	203	Creosote	Boiling	No	For butts of poles only
17a	159 170 171	203	Creosote	Boiling	No	For butts of poles only

THE PRELIMINARY TREATMENT OF TIMBER TO INSURE A MORE EVEN AND SATISFACTORY IMPREGNATION WITH CREOSOTE.

By David Allerton.

I will premise by stating that my title does not exactly state what I have in mind. I cudgelled my brains, but could not arrive at anything better in the limited time at my command, which is only a few hours. I must also say that what I may suggest does not conflict with any existing method or process. It was brought forcibly to my attention last spring, although it has long been a subject of study with me—that is, to find a method by which the great disparity often noticed, and in fact usually observed, of the great difference in the receptivity of various ties or timbers in a given charge. Mr. Goltra, in his work, has shown graphically the various degrees of absorption in a charge of ties as usually treated; of course there will always, under any condition, be a considerable variation in a charge of carefully selected and sound ties and the same where structural timbers are treated, but is there not possible some method of preliminary treatment by which, without impairing the strength of the wood, the structure of the ties or timbers can be rendered more homogenous, so that with a given amount of oil the penetration will be more uniform? I assume that wood of the same species or variety, where the difference in penetration is marked, often as we have all observed in different parts of the same piece, that portion or piece which takes the oil readily would not be changed in its quality of absorption, but that the more difficult structure could be rendered more susceptible to impregnation, assuming, for instance, in the case of ties with a given quantity of oil—say the usual amount, 2½ or 3 gallons per tie—much more even penetration.

Of course, heat is a necessity in any mode of procedure, and the proper temperature and regulation will undoubtedly be the most important factor in solving this problem, as it is well known that to get good results from hot oil with cold wood is impossible (bear in mind I am not speaking of soft pine or other soft woods that take treatment under any conditions). But here arises another question. Suppose the oil is dropped on the cold wood at a temperature of 180° F. and the heat in the cylinder again raised to 180°, how far into that wood is the temperature 180 degrees. That, of course, depends on the diameter of the pieces. With large dimension timbers it is a very little ways, unless a long time has been consumed, and even then the center of the wood is very much cooler than the outside. This is one reason why large timbers such as 12 inch by 12 inch, or 12 inch by 14 inch, are very hard to treat. Taking this into consideration, I think the next most important

factor will be air in conjunction with the heat in current, or compressed moist or dry, and perhaps attenuated by more or less vacuum, as the situation will be found to demand, and in all probability the process will be varied somewhat for different species.

I assume that all will agree that the better seasoned the great majority of wood is the easier and more satisfactorily it can be treated, therefore I also assume that a preliminary treatment can be found, and very likely some of you have discovered the means by which, with the necessary adjuncts to the treating cylinder, or in accessory and less expensive cylinders, by use of which valuable time can be saved and the wood can be prepared to accomplish the best results.

I trust that I have presented the case so that it will be understood, and I regret that the very limited time at my disposal will not permit me to go into the subject at length, as I would like to do, but I reflect that there are others probably better informed on this subject than I am, and I hope that facts of value will be brought out as this question is submitted to discussion, or that it may form a subject for future papers.

I will close with a quotation, after the fashion of my friend Burkhalter, but not from Hobbs, but from old Isaak Walton: "What is writ, is writ; would it were worthier."

Comments on Mr. Allerton's Paper.

MR. W. F. GOLTRA (written): Referring to Mr. Allerton's paper on "The Preliminary Treatment of Timber to Insure a More Even and Satisfactory Impregnation with Creosote," I desire to make some comments in writing.

Mr. Allerton states that the title of his paper does not exactly state what he has in mind, and from what follows I would imagine the title should read, "The Preliminary Treatment of Timber to Secure a More Thorough Impregnation with Antiseptics." It is just as important that the timber shall be properly seasoned when treated with zinc chloride or any other substance, as it is with creosote oil.

Preliminary treatment or seasoning, prior to injection of the antiseptics into the wood, is the most essential factor in the process of treating wood. Timber may be prepared for injection of the antiseptics in three ways:

(1) Open Air Seasoning, which is the common practice.
(2) Steaming in the impregnating cylinders prior to injection of the antiseptics.
(3) By Steaming in Cylinders separate from impregnating cylinders, followed by a period of air drying and the completion of seasoning and warming of the timber in drying ovens.

Boiling of timber in oil or in chemicals, in the impregnating retort, has the same effect as steaming, which is the second method mentioned above.

No one will dispute the fact that the better the timber is seasoned, the easier and more satisfactory it can be treated, and if it is warm when introduced into the impregnating cylinder, it will imbibe the oil or chemical more freely and rapidly, and there will be a more thorough absorption and dissemination of the antiseptic into the wood. Mr. Allerton very clearly points out one of the chief causes for poor work when he says, "to get good results from hot oil with cold wood is impossible." The timber should be warm when introduced into the impregnating cylinder, provided it is not given a preliminary steaming or boiling before injection of the antiseptic. The wood should be as warm as the fluid itself, which is dropped upon it, in order to secure the best possible penetration. As there is a great variation in the absorption of the individual pieces in each charge, the injection should be carried to total refusal to insure that the impregnation is as thorough as it is possible to make it.

Means have been discovered by which timber can be given a preliminary treating or seasoning that will produce better results than now obtainable. The method is to steam the timber in cylinders, separate from the impregnating cylinders, and complete the drying in drying ovens and at the same time warm the ties, so that they will be in prime condition to imbibe the antiseptic when placed in the impregnating cylinder. Steaming and impregnating timber in the same cylinder has not been found satisfactory or economical, and the work should be performed in separate cylinders,—the steaming cylinders being much less expensive than the impregnating cylinders. With the necessary adjuncts to the treating cylinders, such as separate steaming cylinders and drying ovens, much valuable time can be saved and the wood can be put in such condition as to produce the best results.

As most of you know, Mr. Allerton is one of the oldest and most highly respected members of this association. He has perhaps had as long and varied experience in timber treating as any member of our association, therefore his statements should carry a great deal of weight and receive very careful consideration.

SOME FACTS ABOUT
TREATING RAILROAD TIES

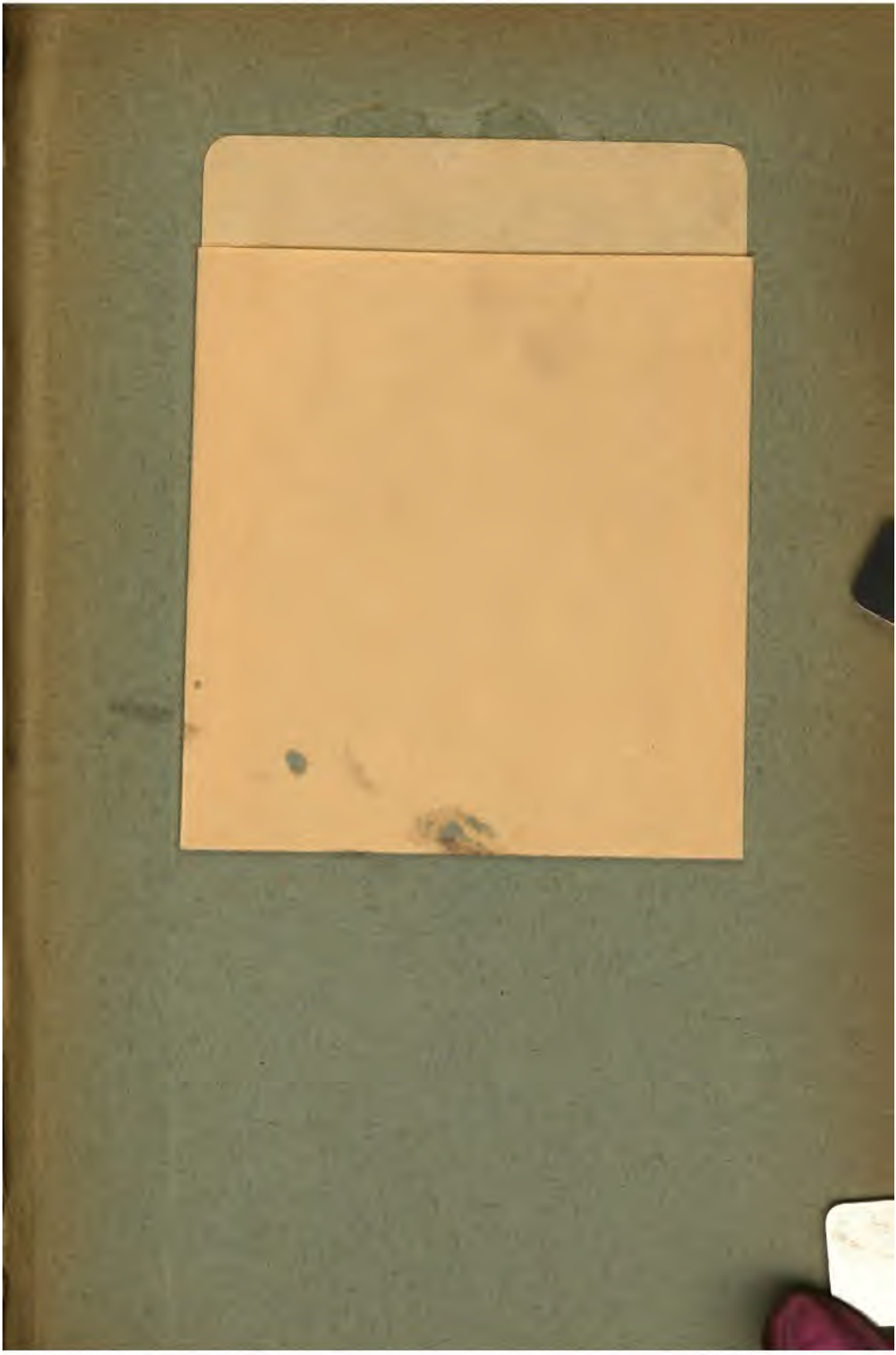
BY W. F. GOLTRA

The above is the title of a treatise on tie and timber preservation. The results of many years of experience, study and research in this important subject are embodied in this work. The treatise carries out its suggestive title, in that FACTS are dealt with and NOT THEORIES. The book contains a number of articles that have appeared in the technical press, contributed by Mr. Goltra and others in which the subject matter is considered from all angles.

Part I gives comprehensive descriptions of the various processes of wood preservation that are in present use. Part II is devoted to recent improved methods of treating railroad ties and timbers which are the result of extended research and experience on the part of the author. Part III consists of a discussion of "Mechanical Life" of ties and "Essentials for Effective Work in Timber Treating." Part IV contains a comparison of zinc chloride with creosote for perserving cross ties, Part V "A History of Wood Preservation in Europe and America" and Part VI contains a list of treating plants, showing their location, managing companies, year built, capacity, kinds of woods treated, kinds of materials treated, preservatives used, processes employed, together with a map showing the Forest Regions and locations of all timber treating plants in North America.

BOUND IN THREE PAMPHLETS, 200 PAGES 6x9 INCHES,
PAPER COVERS, PRICE $1.50 PER SET

THE W. F. GOLTRA TIE CO.
CLEVELAND, OHIO.

89090510538

b89090510538a